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Working Party on Noise (GRB)

(Thirty-fifth session, 13 and 14 September 2001,  
agenda item 2.1.)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 51

(Noise of M and N categories of vehicles)

Transmitted by the Expert from Germany

Note: The text reproduced below was prepared by the expert from Germany and distributed without a symbol (informal document No. 3) during the thirty-fourth session of GRB. The background information for the proposal was given in informal document No. 2, whilst the informal document No. 1 contained a comparison with other related proposals; these two informal documents are not incorporated in the present text (TRANS/WP.29/GRB/32, para. 22).

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Note: This document is distributed to the Experts on Noise only.

Insert new paragraphs 2.8. and 2.9., to read:

- "2.8.        "Kerb mass" means the complete shipping mass of a vehicle without the driver, fitted with all equipment necessary for normal operation plus the mass of the following elements:
- lubricants, coolant (if needed), washer fluid,
  - fuel (tank filled to at least 90 per cent of the capacity specified by the manufacturer),
  - other equipment if included as basic parts for the vehicle such as:
  - spare wheel(s), wheel chocks, fire extinguisher(s), spare parts, and tool-kit.
- 2.9.        "Payload" means ... (to be proposed)"

Insert new paragraphs 6.4. to 6.4.3., to read:

"6.4.        Cycle by-pass prevention

To avoid that the noise reduction measures are only effective at those driving conditions covered by the measuring method of paragraph 3.1.2.4., the manufacturer has to assure that the following conditions are fulfilled:

6.4.1.        Vehicles of category  $M_1$

At any vehicle speed below  $V_B$ , at any engine rotational speed below  $N_B$  and at any load condition of the engine (between motoring and full load), the noise emission of the vehicle shall not exceed the noise level measured by the method described in annex 3, paragraph 3.1.2.2 (for  $V_B$  and  $N_B$  see annex 3, paragraph 3.1.2.1).

If the vehicle is tested in different gears by the method mentioned above this condition is requested for each gear separately.

6.4.2.        Vehicles of category  $N_1$

At any vehicle speed below  $V_B$ , at any engine speed below  $0.8 S$  and at any load condition of the engine (between motoring and full load) the noise emission of the vehicle must not exceed the noise level, measured by the method described in annex 3, paragraph 3.1.2.3 (for  $V_B$  and  $S$  see annex 3, paragraph 3.1.2.1).

6.4.3.        Vehicles of categories other than  $M_1$  and  $N_1$

At any vehicle speed below  $V_B$ , at any engine rotational speed below  $0.85 S$  and at any load condition of the engine (between motoring and full load) the noise emission of the vehicle must not exceed the noise level, measured by the method described in annex 3, paragraph 3.1.2.4 (for  $V_B$  and  $S$  see annex 3, paragraph 3.1.2.1)."

Annex 3, paragraphs 1. to 3., amend to read:

"1. MEASURING INSTRUMENTS

1.1. Acoustic measurements

The sound level meter or the equivalent measuring system, including the windscreen recommended by the manufacturer shall at least meet the requirements of Type 1 instruments in accordance with IEC 60651.

The measurements shall be made using the frequency weighting A, and the time weighting F.

When using a system that includes a periodic monitoring of the A-weighted sound level, a reading should be made at a time interval not greater than 30 ms.

1.1.1. Calibration

At the beginning and at the end of every measurement session the entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of at least precision Class 1 according to IEC 60942. Without any further adjustment the difference between the readings of two consecutive checks shall be less than or equal to 0.5 dB. If this value is exceeded the results of the measurements obtained after the previous satisfactory check shall be discarded.

1.1.2. Compliance with requirements

The compliance of the sound calibration device with the requirements of IEC 60942 shall be verified once a year, and the compliance of the instrumentation system with the requirements of IEC 60651, second edition, shall be verified at least every two years, by a laboratory which is authorized to perform calibrations traceable to the appropriate standards.

1.2. Speed measurements

The rotational speed of the engine and the vehicle speed shall be measured with instruments with an accuracy of  $\pm 2$  per cent or better.

1.3. Meteorological instrumentation

The meteorological instrumentation used to monitor the environmental conditions shall include the following:

- (i) A temperature measuring device which shall be accurate within  $\pm 1$  °C;
- (ii) a wind speed measuring device which shall be accurate within  $\pm 1.0$  m/s;
- (iii) a barometric pressure measuring device meeting specification limits of  $\pm 5$  hPa;
- (iv) a humidity measuring device meeting specification limits of  $\pm$  [xx] per cent.

2. CONDITIONS OF MEASUREMENT

2.1. Site

- 2.1.1. The test site must consist of a central acceleration section surrounded by a substantially flat test area.

The acceleration section must be level; the track surface must be dry and such that rolling noise remains low.

The test track must be such that the conditions of a free sound field between the sound source and the microphone are attained to within 1 dB. This condition shall be deemed to be met if there are no large sound-reflecting objects such as fences, rocks, bridges or buildings within 50 m of the centre of the acceleration section. The surface of the site must be in accordance with the provisions given in annex 8 to this Regulation and be free of powdery snow, tall grass, loose soil or cinders. There must be no obstacle that could affect the sound field within the vicinity of the microphone and the sound source. The observer carrying out the measurements must so position himself as not to affect the readings of the measuring instrument.

Note: It is recommended that the test area be a substantially flat plane, particularly in the portion of the area between the vehicle path and the microphone location.

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

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.

- 2.1.2.1. The meteorological instrumentation should be positioned adjacent to the test area at a height of 1.2 m  $\pm$  0.1 m.

The measurements shall be made when the ambient air temperature is within the range from 0 °C to 40 °C.

Tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval and shall be recorded during each test run.

Values representative of temperature, wind speed and direction, relative humidity, and barometric pressure shall be recorded during the sound measurement interval.

The meteorological instrumentation should be positioned adjacent to the test area at a height representative of the site.

Note: When comparing data under different environmental conditions, the effects of temperature and other factors should be considered.

- 2.1.3. It is recommended that the A-weighted background noise (including any wind noise) is 15 dB below the emissions produced by the vehicle under test, but it shall always be at least 10 dB below.

2.2. Vehicle

2.2.1. For the measurements the vehicle shall be in the following loading conditions:

i) Vehicles of category  $M_1$ ,  $M_2$  and  $M_3$

The mass ( $m_t$ ) of the vehicle for the tests in kg is given by the following formula:

$$m_t = m_k + 75 \text{ kg}$$

ii) Vehicles of category  $N_1$

The mass of the vehicle for the tests ( $m_t$ ) in kg is given by the following formula:

$$m_t = m_k + 0.5 m_p$$

iii) Vehicles of category  $N_2$  and  $N_3$

The mass ( $m_t$ ) of the vehicle for the tests in kg is given by the following formula:

$$m_t = 50 P_n \quad (P_n \text{ in kW})$$

but not exceeding the max. allowed mass of the vehicle or 75 per cent of the max. axle load. Vehicles with more than two axles shall be tested with the same mass as vehicles of the same type with two axles.

2.2.2. Tyres and inflation pressure

2.2.2.1. Tyres

The tyres used for the test shall correspond to one of the tyre size and type designated by the vehicle manufacturer as original equipment for the vehicle. They are selected by the technical service. They shall meet the maximum tread depth.

2.2.2.2. Inflation pressure

2.2.2.2.1. Vehicles of categories  $M_1$  and  $N_1$

The tyres shall be inflated to the pressure recommended by the tyre manufacturer for the test mass of the vehicle.

2.2.2.2.2. Vehicles of categories other than  $M_1$  and  $N_1$

The tyre inflation pressure shall be adjusted to the actual axle load as recommended by the tyre manufacturer.

2.2.3. The vehicle shall be supplied with fuel, spark plugs, a fuel supply system, etc., as specified by the vehicle manufacturer.

Before the measurements are started, the vehicle shall be brought to its normal operating conditions with respect to temperatures and tuning as specified by the vehicle manufacturer.

- 2.2.4. 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. If the vehicle is fitted with fan(s) having an automatic actuating mechanism, this system must not be interfered with during the measurements.
- 2.2.6. If the vehicle is equipped with an exhaust system containing fibrous materials, the exhaust system is to be conditioned before the test according to annex 5.
- 2.2.7. If the vehicle is fitted with an auxiliary manual transmission or a multi-gear axle, the position used for normal urban driving shall be used.

In all cases, the gear ratios for slow movements, parking or braking shall be excluded.

### 3. METHODS OF TESTING

#### 3.1. Measurement of noise of vehicles in motion

##### 3.1.1. General conditions of test (see appendix, fig. 1a and 1b)

- 3.1.1.1. At least four measurements shall be made for each driving condition on each side of the vehicle. If a sound peak obviously out of character with the general sound pressure level is observed, it shall be disregarded. Preliminary measurements may be made for adjustment purposes, but shall be disregarded.

The noise measurement results shall be considered valid when the values from four consecutive measurements on each side of the vehicle do not differ more than 2 dB(A). If not, additional tests shall be made until the values from four consecutive measurements on either side of the vehicle do not differ more than 2 dB(A).

For each run the vehicle speed  $V_A$  and  $V_B$  shall be measured to calculate the vehicle acceleration.

- 3.1.1.2. The distance from the microphone positions on the microphone line PP', perpendicular to the reference line CC' (see Figure 1) of the test track shall be  $7.5 \text{ m} \pm 0.05 \text{ m}$ .

The microphone shall be located  $1.2 \text{ m} \pm 0.02 \text{ m}$  above the ground level. The reference axis for free field conditions (see IEC 60651) shall be horizontal and directed perpendicularly towards the path of the vehicle line CC'.

Calibration of the microphone has to be done before and after a test session. Results have to be refused, if the values have a variation of more than 0.5 dB(A).

- 3.1.1.3. ~~Two lines, AA' and BB', parallel to line PP' and situated respectively 10 m forward and 10 m rearward of that line shall be marked out on the test runway.~~

The vehicle shall be driven in a straight line over the acceleration section in such a way that the longitudinal median plane of the vehicle is as close as possible to the line CC' and approach line AA' at a steady speed as specified below.

3.1.1.3.1. Vehicles of categories  $M_1$  and  $N_1$

When the front of the vehicle reaches the line AA', the accelerator control shall be fully engaged as rapidly as practicable and held in the fully-engaged position until the rear of the vehicle crosses line BB' (appendix, figure 1a), the accelerator control shall then be released.

3.1.1.3.2. Vehicles of categories other than  $M_1$  and  $N_1$

When the front of the engine reaches the line AA', the accelerator control shall be fully engaged as rapidly as practicable and held in the fully-engaged position until the front of the engine crosses line DD' (see appendix, figure 1b), the accelerator control shall then be released.

Line DD' is parallel to line PP' and situated respectively 15 m forward of line PP' (see appendix, figure 1b). For practical reasons the two lines  $H_sH_s'$  and  $H_eH_e'$ , which are related to the front of the vehicle may be marked out on the test runway (see appendix, figure 1b).

3.1.1.4. In the case of articulated vehicles consisting of two non-separable units regarded as a single vehicle, the semi-trailer shall be disregarded in determining when line BB' is crossed.

3.1.1.5. The maximum sound pressure level expressed in A-weighted decibels (dB(A)) shall be measured when the vehicle is driven in the acceleration test.

3.1.2. Determination of the driving conditions

3.1.2.1. Symbols used

The letter symbols used in this paragraph have the following meaning:

- $a_T$ : target acceleration in  $m/s^2$
- $a_{m,i}$  mean value of the vehicle acceleration in gear  $i$  in  $m/s^2$
- $a_{m,i+1}$  mean value of the vehicle acceleration in gear  $i+1$  in  $m/s^2$
- $l_{veh}$ : length of the vehicle in m
- $m_K$ : kerb mass of the vehicle (see para. 2.8. of this Regulation)
- $m_p$  payload (see 2.9. of this Regulation)
- $m_t$ : test mass of the vehicle (see para. 2.2.1.)
- $N_A$ : uniform engine rotational speed in  $min^{-1}$  when the front of the engine crosses line AA' (other than  $M_1 + N_1$ )
- $N_B$ : engine rotational speed when the rear of the vehicle crosses line BB' in  $min^{-1}$  (vehicles of categories  $M_1 + N_1$ )
- $N_D$ : engine rotational speed when the front of the engine crosses line DD' in  $min^{-1}$  (vehicles of categories other than  $M_1 + N_1$ )

- $P_n$ : rated engine power (ECE) in kW (see para. 2.7. of this Regulation)
- $P/m$ : power to mass ratio in kW/t
- $S$ : rated engine rotational speed (engine rotational speed as indicated under 5.4. of annex 1) in  $\text{min}^{-1}$ .
- $V_A$ : uniform vehicle speed in km/h when  
 - the front of the vehicle crosses line AA' (vehicles of categories  $M_1 + N_1$ )  
 - the front of the engine crosses line AA' (vehicles of categories other than  $M_1 + N_1$ )
- $V_B$ : vehicle speed in km/h when the rear of the vehicle crosses line BB' (vehicles of categories  $M_1 + N_1$ ).
- $V_{BT}$ : vehicle target end speed when the rear of the vehicle crosses line BB' (vehicles of categories  $M_1 + N_1$ )
- $V_{\max}$ : maximum vehicle speed in km/h declared by the vehicle manufacturer.

### 3.1.2.2. Vehicles of category $M_1$ and $N_1$

#### 3.1.2.2.1. Power to mass ratio

The power to mass ratio  $P/m$  of the vehicle shall be calculated by the following formula:

$$P/m = P_n / (m_k + 75 \text{ kg})$$

#### 3.1.2.2.2. Approach speed and gear selection

##### 3.1.2.2.2.1. Vehicles with a manually-controlled gearbox or an automatic transmission with a manual selector

###### 3.1.2.2.2.1.1. Approach speed

The vehicle shall approach the line AA' at a steady speed of  $V_A = 50 \text{ km/h}$ .

###### 3.1.2.2.2.1.2. Vehicle acceleration and end speed

- a) The target acceleration  $a_T$  shall be calculated by the following formula:

$$a_T = (0.01 P/m + 0.87) \text{ m/s}^2 \quad P/m \text{ in kW/t}$$

If the power to mass ratio  $P/m$  of the vehicle exceeds 120 kW/t, the target acceleration  $a_T$  shall be  $2.07 \text{ m/s}^2$ .



- b) The vehicle target end speed  $V_{BT}$  (when the rear of the vehicle crosses line BB') shall be calculated by the following formula:

$$V_{BT} = \sqrt[2]{V_A^2 + 2 * 3,6^2 * a_T (l_{veh} + 20)} \quad \text{in km/h}$$

with:

$V_A$             in km/h  
 $a_T$             in  $m/s^2$   
 $l_{veh}$           in m

- c) The vehicle acceleration in a single test shall be calculated by the following formula:

$$a = \frac{V_B^2 - V_A^2}{2 * 3,6^2 * (20 + l_{veh})} \quad \text{in } m/s^2$$

with:

$V_A$  and  $V_B$    in km/h  
 $l_{veh}$           in m

- d) The mean value of the vehicle acceleration of four test runs shall be calculated by the following formula:

$$a_m = \frac{a_1 + a_2 + a_3 + a_4}{4}$$

### 3.1.2.2.2.1.3. Gear selection

The selection of the gear or the position of the manual selector depends on the target acceleration at required for the full throttle acceleration test.

The following conditions for selection of the gear are possible:

- i) If one specific gear  $i$  / one specific position of the manual selector gives a vehicle speed  $V_B$  in a tolerance band of  $\pm 5$  per cent of the vehicle target end speed  $V_{BT}$ , this gear  $i$  / position  $i$  of the manual selector shall be used for the tests;  
Four runs in this gear / position  $i$  of the manual selector shall be carried out.
- ii) If none of the gears / positions of the manual selector give a vehicle speed  $V_B$  in a tolerance band of  $\pm 5$  per cent of the vehicle target end speed  $V_{BT}$ , then choose a gear  $i$  / positions  $i$  of the manual selector, with a vehicle speed  $V_B$  higher and a gear  $i+1$  / positions  $i$  of the manual selector, with a vehicle speed  $V_B$  lower than the vehicle target end speed  $V_{BT}$ .

Four runs in the gear  $i$  / positions  $i$  of the manual selector and four runs in the gear  $i+1$  / positions  $i+1$  of the manual selector shall be carried out.

3.1.2.2.2.2. Vehicles with no gearbox or an automatic transmission without a manual selector

3.1.2.2.2.2.1. Approach speed

i) For vehicles with no transmission control, the uniform speed at the approach of line AA' will be  $V_A = 50$  km/h.

If  $N_B$  exceeds  $0.8 S$ ,  $V_A$  has to be decreased until  $N_B$  equals  $0.8 S$ . Preliminary measurements may be carried out to adjust  $V_A$  to the appropriate value.

ii) For vehicles with no gearbox or vehicles powered by an electric motor

$$V_A = 0.75 \cdot V_{\max} \text{ or } V_A = 50 \text{ km/h,}$$

whichever is the lower.

Four runs shall be carried out.

3.1.2.3. Vehicles of category  $N_1$

3.1.2.3.1. Vehicles with a manually-controlled gearbox or an automatic transmission with a manual selector

The engine speed  $N_B$  at the end of the test track (see annex 3, appendix, Figure 1a) shall be  $0.8 S$  ( $\pm 1$  per cent). The gear or the selector position has to be chosen in that way, that the approach speed at the line AA' is within 35 km/h and 50 km/h.

If more than one gear or selector position fulfil these requirements, that one with the highest approach speed shall be chosen. Preliminary measurements may be carried out to find out the appropriate condition.

3.1.2.3.2. Vehicles with no gearbox or an automatic transmission without a manual selector

i) For vehicles with no transmission control, the engine speed  $N_B$  at the end of the test track (see annex 3, appendix, Figure 1a) shall be  $0.8 S$  ( $\pm 1$  per cent).

If this condition leads to a uniform speed at the approach of line AA' higher than 50 km/h, the approach speed shall be 50 km/h.

ii) For vehicles with no gearbox or vehicles powered by an electric motor

$$V_A = 0.75 V_{\max} \text{ or } V_A = 50 \text{ km/h,}$$

whichever is the lower.

Four runs shall be carried out.

3.1.2.4. Vehicles of categories other than  $M_1$  or  $N_1$

3.1.2.4.1. Vehicles with a manually-controlled gearbox or an automatic transmission with a manual selector

The engine rotational speed  $N_D$  shall be in a tolerance band of  $\pm 1$  per cent of  $0.8 S$  (see appendix, figure 1b). The gear or the selector position has to be chosen in that way, that the approach speed  $V_A$  of the vehicle at the line AA' is within 35 km/h and 50 km/h.

If there are more than one gear or selector position that fulfil these requirements, the gear or selector position in which the vehicle has the highest approach speed  $V_A$  shall be chosen for the tests.

Four runs in this gear/selector position shall be carried out.

3.1.2.4.2. Vehicles with no gearbox or an automatic transmission without a manual selector

- i) For vehicles with no transmission control, the engine rotational speed  $N_D$  shall be in a tolerance band of  $\pm 1$  per cent of  $0.8 S$  (see appendix, figure 1b). If this condition leads to a vehicle speed  $V_A$  at the approach of line AA' higher than 50 km/h, the vehicle speed  $V_A$  shall be 50 km/h.
- ii) For vehicles with no gearbox or vehicles powered by an electric motor

The vehicle shall approach the line AA' at a steady speed of

$$V_A = 0.75 V_{\max} \quad \text{or} \quad V_A = 50 \text{ km/h,}$$

whichever is the lower.

Four runs shall be carried out.

3.1.3. Interpretation of results

3.1.3.1. Measurement result for a particular test condition  $L_m$

The maximum sound pressure level expressed in A-weighted decibels (dB(A)) shall be measured as the vehicle is driven between

- lines AA' and BB', in the case of vehicles of categories  $M_1$  and  $N_1$  (see appendix, figure 1a);
- lines  $H_S H_S'$  and  $H_e H_e'$ , in the case of vehicles of categories other than  $M_1$  and  $N_1$  (see appendix, figure 1b),

The measurements of noise - for each gear / selector position or test speed - shall be considered valid if four consecutive measurements on each side of the vehicle do not differ more than 2 dB(A). If not, additional runs shall be made until four consecutive measurements on either side do not differ more than 2 dB(A).

Note: The spread of results between runs may be reduced if there is a 1 minute wait, at idle in neutral, between runs.

3.1.3.2. Test result  $L_T$

3.1.3.2.1. Noise tests only in one particular gear or one position of the manual selector

If the noise test had to be carried out only in one particular gear or one position of the manual selector, the intermediate noise measurement result  $L_m$  shall be calculated separately for both sides of the vehicle by the following formula:

$$L_m = \frac{L_1 + L_2 + L_3 + L_4}{4}$$

The higher of the two intermediate measurement result  $L_m$  shall be the noise measurement test result  $L_T$

3.1.3.2.2. Noise tests in two consecutive gears or two selector positions

If the noise test had to be carried out in two consecutive gears or two selector positions, the intermediate noise measurement results  $L_{m,i}$  (for gear  $i$  / selector position  $i$ ) and  $L_{m,i+1}$  (for gear  $i+1$  / selector position  $i+1$ ) shall be calculated for both sides of the vehicle by the following formula:

$$L_{m,i} = \frac{L_1 + L_2 + L_3 + L_4}{4}$$

The noise measurement test result  $L_T$  shall be the weighted average of both intermediate results (in gear  $i$  / selector position  $i$  and gear  $i+1$  / selector position  $i+1$ ) calculated by the following formula:

$$L_T = \frac{L_{m,i} (a_T - a_{m,i+1}) + L_{m,i+1} (a_{m,i} - a_T)}{a_{m,i} - a_{m,i+1}}$$

with:

$a_T$  = target acceleration (see 3.1.2.2.2.1.2)

$a_{m,i}$  = mean value of the vehicle acceleration in gear  $i$   
(see 3.1.2.2.2.1.2)

$a_{m,i+1}$  = mean value of the vehicle acceleration in gear  $i+1$   
(see 3.1.2.2.2.1.2)

3.1.3.3. To allow for a lack of precision in the measuring instrument the test result  $L_T$  shall be reduced by 1 dB (A) and shall be rounded to the nearest integer. This value determines the final test result  $L_{FT}$ ."

Annex 3, appendix, figure 1, amend to read:

"Measuring position for vehicles of categories M<sub>1</sub> and N<sub>1</sub>

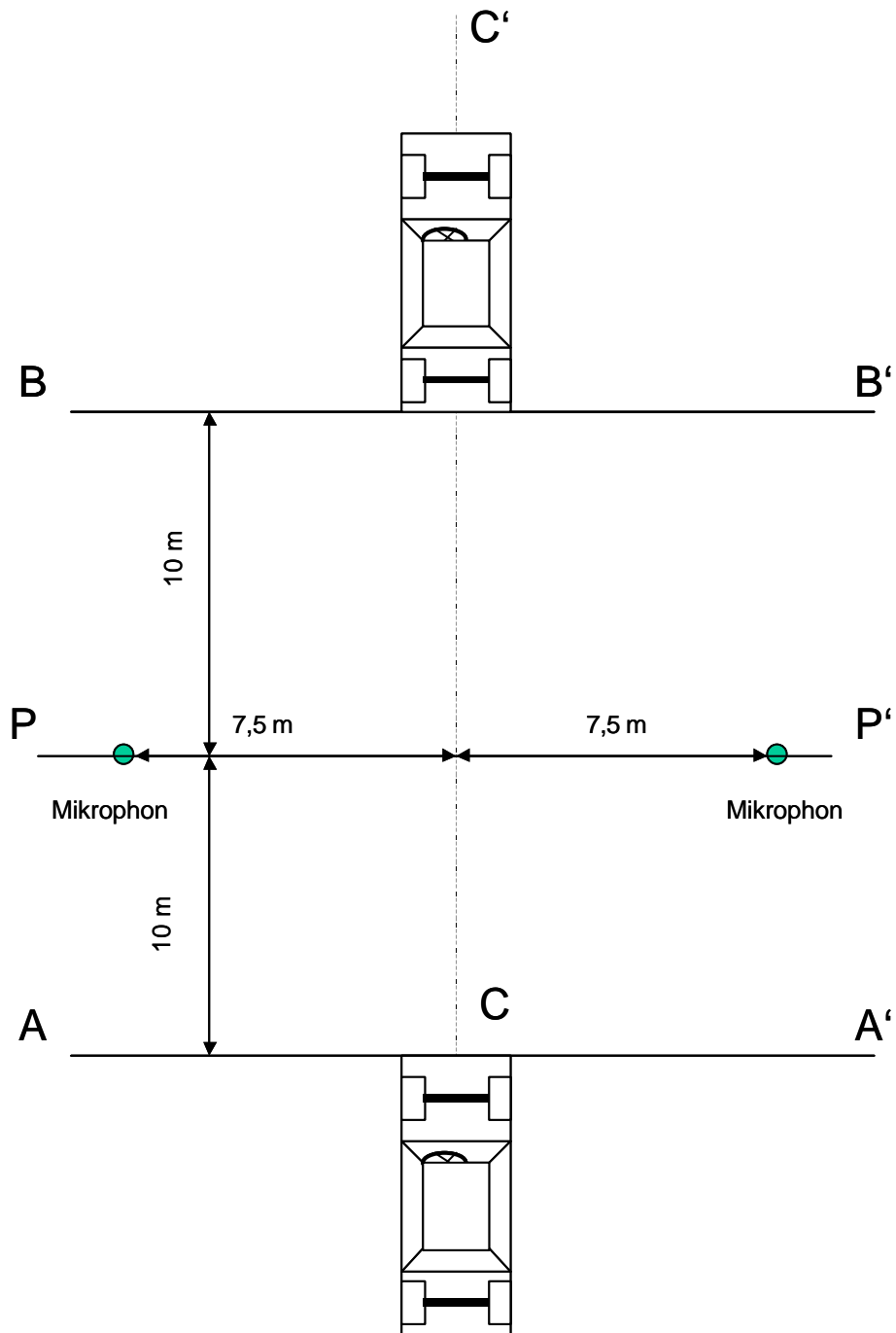


Figure 1a

Measuring position for vehicles of categories other than  $M_1$  and  $N_1$

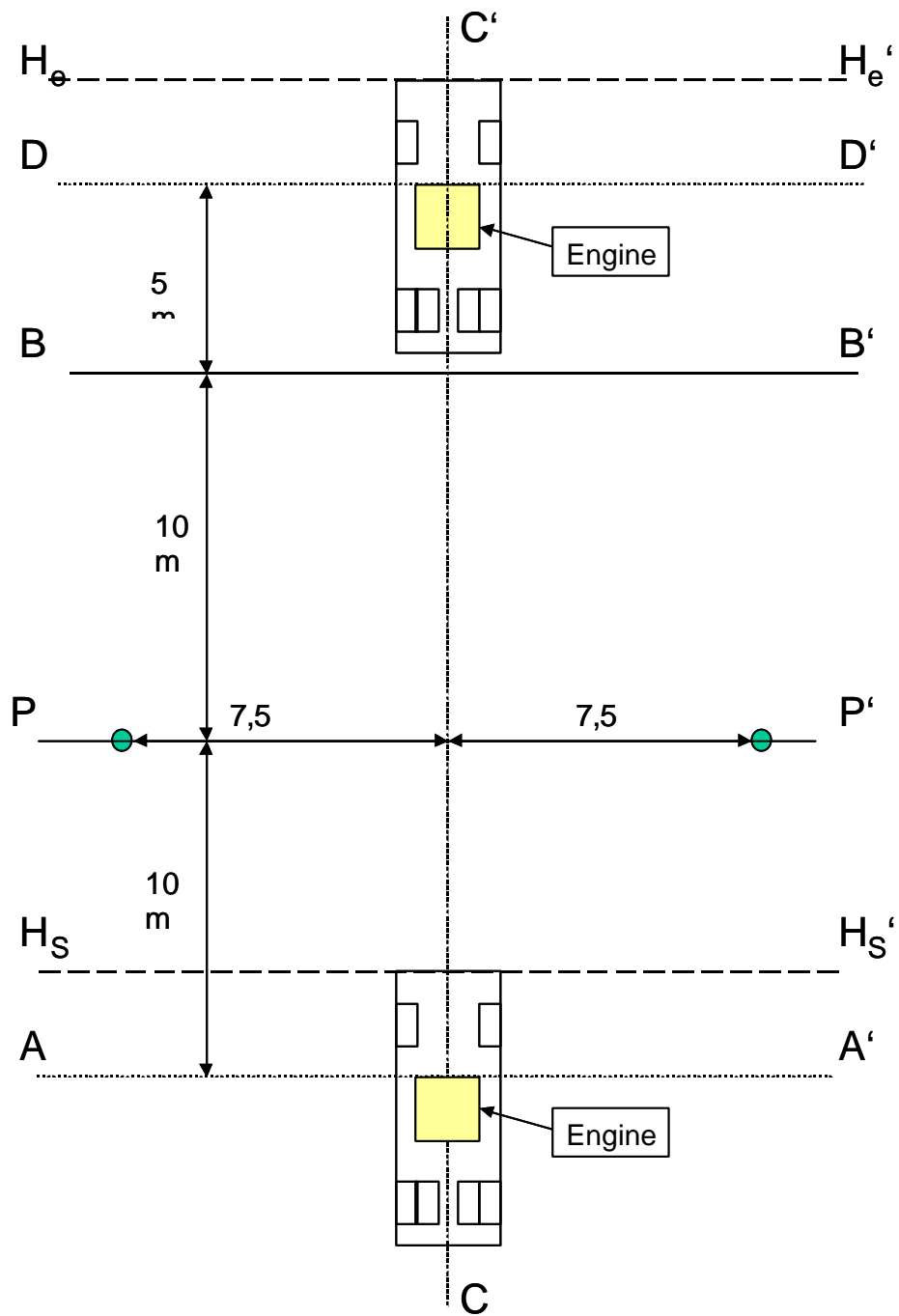


Figure 1b"