

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*

(Revision 2, including the amendments entered into force on 16 October 1995)

Addendum xx: Regulation No. xx

Revision 00

Incorporating all valid text up to:
00 series to the original version of the Regulation – Date of entry into force: xx xxxx xxxx

Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility



* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

Regulation No. xx

Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility

Contents

	<i>Page</i>
1. Scope.....	3
2. Definitions	3
3. Application for approval	5
4. Markings	5
5. Approval	6
6. Specifications	7
7. Modification and extension of approval of a vehicle type	9
8. Conformity of production.....	10
9. Penalties for non-conformity of production	10
10. Production definitively discontinued.....	10
11. Transitional provisions.....	11
12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities.....	11
Annexes	
1. Communication.....	12
2. Arrangements of the approval mark	14
3. Methods and instruments for measuring the sound made by motor vehicles	15
Appendix: Measuring positions for vehicles in motion.....	23

1. Scope

This standard applies to vehicles of categories M and N with either electric- or hybrid-electric drive for which the vehicle's propulsion system can propel the vehicle in the normal travel mode, in reverse or at least one forward drive gear, without an internal combustion engine operating¹.

2. Definitions

For the purpose of this Regulation,

- 2.1. "Approval of a vehicle" means the approval of a vehicle type with regard to sound;
- 2.2. "Acoustic Vehicle Alerting System" (AVAS) means a component or set of components installed to vehicles with the primary purpose to fulfil the requirements of this Regulation
- 2.3. "Vehicle type" means a category of motor vehicles which does not differ essentially in such respects as:
- 2.3.1 The shape and the materials of the bodywork of the vehicle which affect the sound level emitted.
- 2.3.2. The principle of the drivetrain (from the batteries to the wheels).
Vehicles having different overall gear ratios and a range extender and different batteries or differs in only one of these features are regarded as vehicles of the same type
- 2.3.3. If applicable, the number and type(s) of sound emitting devices (hardware) of AVAS fitted on the vehicle;
- 2.3.4. If applicable, the position of the AVAS on the vehicle;
- 2.9. "Electric Vehicle" (EV) means a motor vehicle with an electric motor as its sole mean of propulsion.
- 2.10. "Frequency Shift" means the variation of the frequency content of the AVAS sound as a function of the vehicle speed.
- 2.13. "Hybrid Electric Vehicle" (HEV) means a Hybrid Vehicle (HV) with a powertrain containing at least one electric machine as energy converter and at least one internal combustion engine as propulsion energy converters.
- 2.15. "Internal Combustion Engine vehicle" (ICE vehicle) means a road transport vehicle whose operation relies entirely upon an internal combustion engine to power its drive-train.
- 2.16. "Mass in running order" (mro) means

Kommentar [A1]: It is not clear what this paragraph intends to achieve. If it is simply that a vehicle is considered to be the same type even if it has different batteries, gear ratios or has a range extender then the following may be better: "Notwithstanding the provisions of 2.3.2. vehicles which differ with respect to overall gear ratios, battery type or the fitment of a range extender may be considered vehicles of the same type."

Kommentar [A2]: Doesn't this include an EV unless we also include an IC engine? This is more in line with the definition being proposed by VPSD

Kommentar [A3]: Alternatively the VPSD group has proposed "Internal combustion engine vehicle (ICE vehicle)" means a vehicle equipped with a powertrain containing exclusively ICE(s) as propulsion energy converter(s).

¹ At this stage, only acoustic measures shall be developed in order to overcome the concern of reduced audible signals from EVs / HEVs. After finalisation, the appropriate GR shall be assigned with the enhancement of the Regulation in order to develop alternative, non-acoustic measures, taking into account active safety systems such as, but not limited to, pedestrian detection systems.

- 2.16.1. ~~in the case of a motor vehicle:~~
the mass of the vehicle, with its fuel tank(s) filled to at least 90% of its or their capacity/ies, including the mass of the driver (75 kg), of the fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications and, when they are fitted, the mass of the bodywork, the cabin, the coupling and the spare wheel(s) as well as the tools;
~~shall be included;~~
- 2.18. "Pause function" is a mechanism to halt temporarily the operation of an AVAS.
- 2.19 Front plane of the vehicle means a vertical plane tangent to the leading edge of the vehicle,
- 2.20 Rear plane of the vehicle means a vertical plane tangent to the trailing edge of the vehicle
- 2.21 Symbols and abbreviated terms and the paragraph in which they are first used

Kommentar [A4]: Why is this here, it seems superfluous unless there is going to be a different definition of mro for other vehicle types.

Table 1 : Symbols and abbreviations			
Symbol	Unit	Paragraph	Explanation
AA'	-	Annex 3 §3.3	Line perpendicular to vehicle travel which indicates the beginning of the zone to record sound pressure level during test
BB'	-	Annex 3 §3.3	Line perpendicular to vehicle travel which indicates end of the zone to record sound pressure level during test
CC'	-	Annex 3 §3.1	Centreline of vehicle travel
PP'	-	Annex 3 §3.1	Line perpendicular to vehicle travel which indicates location of microphones
$v_{AA'}$	km/h	Annex 3 §3.3	Vehicle velocity when vehicle reference point in forward motion passes line AA'.
$v_{BB'}$	km/h	Annex 3 §3.3	Vehicle velocity when vehicle reference point or rear of vehicle in forward motion passes line BB'.
$v_{PP'}$	km/h	Annex 3 §3.3	Vehicle velocity when reference point in forward motion passes line PP'.
v_{test}	km/h	Annex 3 §3.3	Target vehicle test velocity
j	-	Annex 3 §3.4	Index for single test run within stopped or constant speed cruise test conditions
L_{back}	dB	Annex 3 §3.5	Vehicle A-weighted sound pressure level in stationary reverse condition.
$L_{crs, 10}$	dB	Annex 3 §3.5	Vehicle A-weighted sound pressure level at a vehicle constant speed of 10 km/h.
$L_{crs, 20}$	dB	Annex 3 §3.5	Vehicle A-weighted sound pressure level at a vehicle constant speed of 20 km/h.
L_{corr}	dB	Annex 3 §2.3.2	Background noise correction
$L_{test,j}$	dB	Annex 3 §2.3.2	A-weighted sound pressure level result of jth test run

$L_{\text{testcorr},j}$	dB	Annex 3 §2.3.2	A-weighted sound pressure level result of j th test run corrected for background noise
L_{bgn}	dB	Annex 3 §2.3.1	Background A-weighted sound pressure level.
$L_{\text{bgn,p-p}}$	dB	Annex 3 §2.3.2	Range of maximum to minimum value of the representative background noise A-weighted sound pressure level over a defined time period.
ΔL	dB	Annex 3 §2.3.2	A-weighted sound pressure level of j th test result minus the A-weighted background noise level ($\Delta L = L_{\text{test},j} - L_{\text{bgn}}$)
v_{ref}	km/h	Annex 3 §4.x	Reference vehicle velocity used for calculating frequency shift percentage.
f_{audible}	Hz	Annex 3 §4.x	Highest audible frequency of external sound generation system
$f_{i,\text{speed}}$	Hz	Annex 3 §4.x	Single frequency component of external sound generation system at a given vehicle speed
$f_{i,\text{ref}}$	Hz	Annex 3 §4.x	Single frequency component of external sound generation system at reference vehicle speed
del_f	%	Annex 3 §4.x	Frequency shift expressed in percent of a reference frequency.
Δf	Hz	Annex 3 §4.x	Frequency resolution of narrowband analysis used to measure frequency spectrums for the purpose of determining frequency shift information.
f_s	Hz	Annex 3 §4.x	Sampling frequency used by digital signal processing system
N	-	v Annex 3 §4.x	Block size of digital sample used for discrete Fourier transform or autopower spectrum analysis

3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to reduced audibility shall be submitted by its manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the undermentioned documents and the following particulars:
 - 3.2.1. A description of the vehicle type with regard to the items mentioned in paragraph 2.3. above. The numbers and/or symbols identifying the engine type and the vehicle type shall be specified;
 - 3.2.2. If applicable, a list of the components constituting the AVAS;
 - 3.2.3. If applicable, a drawing of the assembled AVAS and an indication of its position on the vehicle;
- 3.3. In the case of paragraph 2.3. ~~the a~~ single vehicle, representative of the type in question, will be selected by the ~~Technical Service~~ ~~vehicle_~~ ~~manufacturer~~ conducting approval tests, in accordance with the ~~Technical Service~~ ~~vehicle~~ ~~manufacturer~~.

Kommentar [A5]: The technical service should select the vehicle and conduct the tests not the vehicle manufacturer

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- 3.4. The Type Approval Authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

4. Markings

- 4.1. The components of the AVAS shall bear:
- 4.1.1. The trade name or mark of the manufacturer of the AVAS;
- 4.1.2. The designated part number(s).
- 4.2. These markings shall be clearly legible and be indelible.

Kommentar [A6]: Is this necessary?

5. Approval

- 5.1. Type approval shall only be granted if:
- (a) The vehicle type meets the requirements of paragraphs 6. and 7. below.
- 5.2. An approval number shall be assigned to each type approved. Its first two digits (at present 00 corresponding to the 00 series of amendments which entered into force on 01 September 20xx) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another vehicle type.
- 5.3. Notice of approval or of extension or of refusal or withdrawal of approval or of production definitively discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in Annex 1 to this Regulation.
- 5.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
- 5.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval;
- 5.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 5.4.1.
- 5.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 5.4.1. need not be repeated; in such a case the regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 5.4.1.
- 5.6. The approval mark shall be clearly legible and be indelible.
- 5.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.

5.8. Annex 2 to this Regulation gives examples of arrangements of the approval mark.

6. Specifications

6.1. General specifications

For the purpose of this Regulation, the vehicle shall fulfil the following requirements:

6.2. Acoustics characteristics

The sound emitted by the vehicle type submitted for approval shall be measured by the methods described in Annex 3 to this Regulation.

If the vehicle without an AVAS ~~or another sound emitting device (e.g. horn or siren)~~ fitted fulfils the overall levels as specified in table 2 below with a margin of +[x] dB(A), the specification for one-third octave bands and the frequency shift do not apply.

Kommentar [A7]: All vehicles have a horn which is likely to fulfil the levels in table 2. This para apparently exempts all vehicles from compliance with the specifications for octave bands and frequency shift.

6.2.1 Constant speed tests

6.2.1.1 ~~The speed range for constant speed tests is the range of greater 0 km/h up to and inclusive 20 km/h. The AVAS shall emit a sound at speeds from 0 km/h up to and including 20 km/h~~

Kommentar [A8]: Presumably the intention of this para is to ensure sound is emitted across the entire speed range and not just at 10 and 20 km/h

6.2.1.2. The test speeds for approval are 10 km/h and 20 km/h.

6.2.1.3 When tested under the conditions of Annex 3 paragraph 3.3, the vehicle shall emit a sound

- that has an overall sound level for the applicable test speed according to Table 2 of paragraph 6.2.8.

- that has at least two of the one-third octave bands according to Table 2 of paragraph 6.2.8. At least one of these bands ~~has to~~ shall be below or within the 1600 Hz one-third octave band.

- with sound levels in the chosen bands ~~of at least the sound pressure level in dB(A)~~ for the applicable test speed ~~range~~ according to Table 2 of paragraph 6.2.8 column 3 or column 4.

Kommentar [A9]: Aligns with wording used in first sub para

6.2.1.4 If after a vehicle is tested in accordance with Annex 3 paragraph xxx, for ten consecutive times within a series of measurements without recording a valid measurement because the vehicle's ICE remains active or restarts and interferes with the measurements the vehicle is ~~then~~ exempted from this particular test.

6.2.2. Reversing test

~~[For vehicles already equipped with an audible device indicating the Reversing of the vehicle with a sound level >47dB(A) the requirements of this paragraph do not apply.]~~

Kommentar [A10]: Is this necessary? If such a device is fitted it should still comply with the requirements of 6.2.2.1 etc.

6.2.2.1 When tested under the conditions of Annex 3 paragraph 3.3 the vehicle must emit a sound that has an overall sound level according to Table 2 of paragraph 6.2.8 column 5 ~~when measured under the test conditions specified in Annex 3, paragraph xxx.~~

6.2.2.2 If after a vehicle is tested in accordance with Annex 3, paragraph 3.3.2, for ten consecutive times within a series of measurements without recording a valid measurement because the vehicle's ICE remains active or restarts and interferes with the measurements the vehicle is ~~then~~ exempted from this particular test.

Kommentar [A11]: Para 3.3.2. is for forward motion which is not relevant in this case as the vehicle is reversing. Change to para 3.3.4.1?

6.2.3. Frequency shift to signify acceleration and deceleration

When tested under the conditions of Annex 3 paragraph 4., at least one frequency of the sound emitted by the vehicle shall vary with speed within each individual gear ratio by an average of at least 0.8% per 1 km/h in the speed range from 5 km/h to 20 km/h inclusive when driving in forward direction. [This frequency of the sound shall not be covered by other frequencies of the produced sound.]

Kommentar [A12]: What does this mean?

6.2.4. Stationary sound

The vehicle may emit a sound when stationary at a speed of 0 km/h.

Kommentar [A13]: It doesn't seem necessary to specify a speed of 0 km/h

6.2.5. Sound updates

The vehicle manufacturer may update the sound, provided it is in compliance with the provisions given in paragraphs 6.2.1 to 6.2.3.

Kommentar [A14]: This is very vague. I assume it is intended to allow updates once the vehicle has been placed into service. How will the approval authority verify this? This is entirely outside the area of type approval and I would prefer leaving it out altogether and leave to contracting parties to address at a national level. If it is included then a process will need to be included to allow the approval to be updated to include the new sound but even then that would only cover new types not those vehicles already on the road.

6.2.6. Driver selectable sounds

The vehicle manufacturer may define alternative sounds which can be selected by the driver; each of these sounds shall be in compliance with the provisions in paragraphs 6.2.1 to 6.2.3.

6.2.7. Pause function

~~In case a vehicle is equipped with an AVAS, the manufacturer may install a pause function control for a temporary deactivation of the AVAS, which fulfils the specification below.~~ Any other deactivation function, which does not satisfy the specification below, is prohibited.

6.2.7.1 The pause function control shall be located so that it is operable accessible and operated by the driver in a normal seating position.

6.2.7.2 A tell-tale visible to the driver shall be activated to inform the driver when the AVAS has been deactivated. In the case the pause function is activated, the suspension of AVAS has to be clearly indicated to the driver.

6.2.7.3 The AVAS shall be reactivated. Pause function shall be deactivated when the vehicle is started upon each vehicle turn-off.

6.2.7.4. Owner's manual information

If a pause function is installed, the manufacturer shall provide the owner with information (e.g. in the owner's manual) on its effect:

"The pause function of the Acoustic Vehicle Alerting System (AVAS) should be used only when there is no obvious need to emit an alerting sound. Pedestrians in the near vicinity may not be able to hear the vehicle approaching when the AVAS is deactivated. shall not be used unless for an obvious lack of necessity to emit sound for alert in the surrounding area and that it is certain that there are no pedestrians within the short distance."

Kommentar [A15]: I'm not convinced it is necessary to put specific wording here, I'm sure the legal departments of every manufacturer will be able to produce something more robust than us!

6.2.8. Minimum Sound levels

The sound level measured in accordance with the provisions of Annex 3 to this Regulation, mathematically rounded to the nearest integer value, shall have at least the followings values:

Table 2: Minimum Sound Level Requirements in dB(A)				
Frequency in Hz		Constant Speed Test at 10 km/h	Constant Speed Test at 20 km/h	Reversing Test at 6 km/h
Column 1	Column 2	Column 3	Column 4	Column 5
Overall		50	56	47
1/3rd Octave Bands	160	45	50	X
	200	44	49	
	250	43	48	
	315	44	49	
	400	45	50	
	500	45	50	
	630	46	51	
	800	46	51	
	1.000	46	51	
	1.250	46	51	
	1.600	44	49	
	2.000	42	47	
	2.500	39	44	
	3.150	36	41	
4.000	34	39		
5.000	31	36		

Kommentar [A16]: Is this correct? I've taken it from para 3.3.4.1 annex 3

7. Modification and extension of approval of a vehicle type

- 7.1. Every modification of the vehicle type shall be notified to the Type Approval Authority which approved the vehicle type. The Type Approval Authority may then either: ~~{software and sound}~~.
- 7.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements, or
- 7.1.2. Require a further test report from the Technical Service responsible for conducting the tests.
- 7.2. Confirmation or refusal of approval, specifying the alterations shall be communicated by the procedure specified in paragraph 5.3. above to the Parties to the Agreement applying this Regulation.

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- 7.3. The Type Approval Authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

8. Conformity of production

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2) with the following requirements:

- 8.1. Vehicles approved according to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 6.2 above.
- 8.2. The authority which has granted type approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be one every two years.

9. Penalties for non-conformity of production

- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements set forth above are not met.
- 9.2. If a Contracting Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1 to this Regulation.

10. Production definitively discontinued

- 10.1. If the holder of the approval completely ceases to manufacture a vehicle type approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

11. Transitional provisions

- 11.1. As from the official date of entry into force of the 00 series of this Regulation, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type-approvals under this Regulation.
- 11.2. [As from ...months after the date of entry into force of the 00 series of this Regulation, Contracting Parties applying this Regulation shall grant type-approvals only if the vehicle type to be approved meets the requirements of this Regulation.]
- 11.3. ~~As from~~Until ... months [target date: 30 June 2019] after the date of entry into force of 00 series of this Regulation ISO 10844:1994 may be applied as an alternative to ISO 10844:2014 to check compliance of the test track as described in Annex 3, paragraph x.x.x. of this Regulation.

Kommentar [A17]: I don't think this is necessary, this regulation is not a mandatory requirement unless a contracting party wants to make it so.

12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities

The Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

Communication

(maximum format: A4 (210 x 297 mm))

issued by: Name of administration:

.....
.....
.....



concerning:² APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to its sound emission pursuant to Regulation No. XX

Approval No.

Extension No.

SECTION I

- 0.1. Make (trade name of manufacturer):
- 0.2. Type:
- 0.3. Means of identification of type if marked on the vehicle⁽³⁾:
 - 0.3.1. Location of that marking:
- 0.4. Category of vehicle⁽⁴⁾:
 - 0.4.1 Subcategory according to paragraph 6.2.2, the 2nd column of the table and the paragraphs 6.2.2.1 to 6.2.2.5.
- 0.5. Company name and address of manufacturer:
- 0.6. Names and Address(es) of assembly plant(s):
- 0.7. Name and address of the manufacturer's representative (if any):

¹ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

² Delete what does not apply

³ If the means of identification of type contains characters not relevant to describe the vehicle, types covered by the type-approval certificate such characters shall be represented in the documentation by the symbol: '?' (e.g. ABC??123??).

⁴ As defined in the R.E.3

SECTION II

1. **Additional information (where applicable): See Addendum**
2. **Technical service responsible for carrying out the tests:**
3. **Date of test report:**
4. **Number of test report:**
5. **Remarks (if any): See Addendum**
6. **Place:**
7. **Date:**
8. **Signature:**
9. **Reasons for Extensions**
Attachments:
Information package
Test report(s)

Addendum to the communication form No ...

Technical Information Document

0. **General**
- 0.1. **Make (trade name of manufacturer):**
- 0.2. **Means of identification of type, if marked on the vehicle³:**
 - 0.2.1. **Location of that marking:**
- 0.3 **Category of vehicle⁴:**
- 0.4. **Company name and address of manufacturer:**
- 0.5. **Name and address of the manufacturer's representative (if any):**
- 0.6 **Name(s) and Address(es) of assembly plant(s):**

Signed:

Position in company:

Date:

Annex 2

Arrangements of the approval mark

Model A
(See paragraph 5.4. of this UN Regulation)

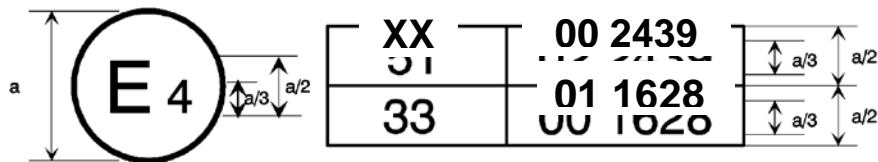


$a = 8 \text{ mm min.}$

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to its noise emission, been approved in the Netherlands (E 4) pursuant to UN Regulation No. XX under approval No. 002439.

The first two digits of the approval number indicate that UN Regulation No. XX already included the 00 series of amendments when the approval was granted.

Model B
(See paragraph 5.5. of this Regulation)



$a = 8 \text{ mm min.}$

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to UN Regulations Nos. XX and 33.¹ The approval numbers indicate that, at the dates when the respective UN approvals were granted, UN Regulation No. XX included the 00 series of amendments while UN Regulation No. 33 included the 01 series of amendments.

¹ The latter number is given as an example only.

Annex 3

Methods and instruments for measuring the sound made by motor vehicles

1. Instrumentation

1.1. Instruments for acoustic measurement

1.1.1. General

The apparatus used for measuring the sound pressure level shall be a sound level meter or equivalent measurement system meeting the requirements of Class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in IEC 61672-1-2013.

The entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements of Class 1 sound calibrators in accordance with IEC 60942-2003.

Measurements shall be carried out using the time weighting "F" of the acoustic measurement instrument and the "A" frequency weighting also described in IEC 61672-1-2013. When using a system that includes a periodic monitoring of the A-weighted sound pressure level, a reading should be made at a time interval not greater than 30 ms.

When measurements are carried out for one-third octaves, the instrumentation shall meet all requirements of IEC 61260-1-2014, class 1.

When measurements are carried out for frequency shift, the digital sound recording system shall have at least a 16 bit quantization. The sampling rate, F_s , and the dynamic range shall be appropriate to the signal of interest.

The instruments shall be maintained and calibrated in accordance to the instructions of the instrument manufacturer.

1.1.2. Calibration

At the beginning and at the end of every measurement session, the entire acoustic measurement system shall be checked by means of a sound calibrator as described in paragraph 1.1.1. Without any further adjustment, the difference between the readings 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.

1.1.3. Compliance with requirements

Compliance of the sound calibrator with the requirements of IEC 60942-2003 shall be verified once a year. Compliance of the instrumentation system with the requirements of IEC 61672-3-2013 shall be verified at least every 2 years. All compliance testing shall be conducted by a laboratory which is authorized to perform calibrations traceable to the appropriate standards.

1.2. Instrumentation for speed measurements

The road speed of the vehicle shall be measured with instruments meeting specification limits of at least $\pm 0,5$ km/h when using continuous measuring devices.

If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least $\pm 0,2$ km/h.

1.3. Meteorological instrumentation

The meteorological instrumentation used to monitor the environmental conditions during the test shall meet the specifications of:

- ± 1 °C or less for a temperature measuring device;
- $\pm 1,0$ m/s for a wind speed-measuring device;
- ± 5 hPa for a barometric pressure measuring device;
- ± 5 % for a relative humidity measuring device.

2. Acoustic environment, meteorological conditions, and background noise

2.1. Test site

2.1.1. General

The specifications for the test site provide the necessary acoustic environment to carry out the vehicle tests documented in this regulation. Outdoor and indoor test environments that meet the specifications of this regulation provide equivalent acoustic environments and produce results that are equally valid.

2.1.2. Outdoor testing

The test site shall be substantially level. The test track construction and surface shall meet the requirements of ISO 10844:2014.

Within a radius of 50 m around the centre of the track, the space shall be free of large reflecting objects such as fences, rocks, bridges or buildings. The test track and the surface of the site shall be dry and free from absorbing materials such as powdery snow, or loose debris.

In the vicinity of the microphones, there shall be no obstacle that could influence the acoustic field and no person shall remain between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading. Microphones shall be located as specified in figures 1.

2.1.3. Indoor hemi anechoic or anechoic testing

This paragraph specifies conditions applicable when testing a vehicle, either operating as it would on the road with all systems operational, or operating in a mode where only the external sound generation system is operational.

The test facility shall meet requirements of ISO 26101.2012

The test facility shall have a cut-off frequency, as defined in ISO 26101.2012, lower than the lowest frequency of interest. The lowest frequency of interest is the frequency below which there is no signal content relevant to the measurement of sound emission for the vehicle under test.

In the vicinity of the microphones, there shall be no obstacle that could influence the acoustic field and no person shall remain between the microphone and the noise source.

The meter observer shall be positioned so as not to influence the meter reading. Microphones shall be located as specified in figures 2.

2.2. Meteorological conditions

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

A value representative of temperature, relative humidity, and barometric pressure shall be recorded during the measurement interval.

The meteorological instrumentation shall deliver data representative for the test site and shall be positioned adjacent to the test area at a height representative of the height of the measuring microphone.

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 that can reduce vehicle noise emissions (e.g. start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) are enabled according to manufacturer's specifications.

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

2.3. Background noise

2.3.1. Measurement criteria for A-weighted sound pressure level

The background, or ambient noise, shall be measured for a duration of at least 10 seconds. A 10 second sample taken from these measurements shall be used to calculate the reported background noise, ensuring the 10 seconds sample selected is representative of the background noise in absence of any transient disturbance. The measurements shall be made with the same microphones and microphone locations used during the test

When testing in an indoor facility, the noise emitted by the roller-bench, chassis dynamometer, or other test facility equipment, without the vehicle installed or present, inclusive of the noise caused by air handling, facility vehicle cooling, shall be reported as the background noise.

The recorded maximum A-weighted sound pressure level from both microphones during the 10 second sample shall be reported as the background noise, L_{bgn} , for both left and right microphones.

For each 10 second sample at each microphone, the maximum to minimum range of the background noise, $\Delta L_{bgn, p-p}$, shall be reported.

The one-third-octave frequency spectrum, corresponding to the reported maximum level of background noise in the microphone with the highest background level, shall be reported.

2.3.2. Vehicle A-weighted sound pressure level measurement correction criteria

Depending on the level and the range of maximum to minimum value of the representative background noise A-weighted sound pressure level over a defined time period, the measured j th test result within a test condition, $L_{test,j}$, shall be corrected according to the table below to obtain the background noise corrected level $L_{testcorr,j}$. Except where noted, $L_{testcorr,j} = L_{test,j} - L_{corr}$.

Background noise corrections to measurements are only valid when the range of the maximum to minimum background noise A-weighted sound pressure levels are 2 dB or less.

In all cases where the range of the maximum to minimum background noise is greater than 2 dB, the maximum level of the background noise shall be 10 dB or greater below the level of the measurement. When the maximum to minimum range of background noise is greater than 2 dB and the level of the background noise is less than 10 dB below the measurement, no valid measurement is possible.

Table 1 — Correction for level of background noise when measuring vehicle A-weighted sound pressure level

Correction for background noise		
Range of maximum to minimum value of the representative background noise A-weighted sound pressure level over a defined time period in dB $\Delta L_{bgn, p}$	Sound pressure level of <i>j</i> th test result minus background noise level $\Delta L = L_{test,j} - L_{bgn}$ in dB	Correction in dB L_{corr}
-	$\Delta L_{bgn} \geq 10$	no correction needed
< 2	$8 \leq \Delta L_{bgn} \leq 10$	0,5
	$6 \leq \Delta L_{bgn} \leq 8$	1,0
	$4.5 \leq \Delta L_{bgn} \leq 6$	1,5
	$3 \leq \Delta L_{bgn} \leq 4.5$	2,5
	$\Delta L_{bgn} < 3$ dB	no valid measurement can be reported

If a sound peak obviously out of character with the general sound pressure level is observed, that measurement shall be discarded.

Background compensation is not permitted for one-third octave band measurements.

2.3.3. Background noise requirements when analysing in one-third-octave bands

When analysing one-third octaves according to this regulation, the level of background noise in each one-third octave of interest, analysed according to paragraph 2.3.1, shall be at least 6 dB below the measurement of the vehicle or external sound generation system under test in each one-third-octave band of interest. The A-weighted sound pressure level of the background noise shall be at least 10 dB below the measurement of the vehicle or external sound generation system under test.

Background compensation is not permitted for one-third octave band measurements.

3. Test procedures for vehicle sound level

3.1. Microphone positions

The distance from the microphone positions on the microphone line PP' to the perpendicular reference line CC' as specified in Figure 1 on the test track or in an indoor test facility shall be $2,0 \text{ m} \pm 0,05 \text{ m}$.

The microphones shall be located $1,2 \text{ m} \pm 0,02 \text{ m}$ above the ground level. The reference direction for free field conditions as specified in IEC 61672-1:2013 shall be horizontal and directed perpendicularly towards the path of the vehicle line CC'.

3.2. Conditions of the vehicle

3.2.1. General conditions

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.

In the case of HEVs, the test has to be carried out in the most energy efficient mode so to avoid the restart of the combustion engine, e.g. all audio, entertainment, communication and navigation systems shall be switched off.

All vehicle loads which may have an influence on the test result which can be turned off by the driver shall be turned off.

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

3.2.2. 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 manufacturer's specifications. Propulsion batteries shall be within their component-temperature window to enable all key functionalities that could reduce vehicle noise emissions. Any other type of rechargeable energy storage system shall be ready to operate during the test.

3.2.3. Multi-mode operation

If the vehicle is equipped with multiple driver selectable operating modes, the mode which provides the lowest sound emission during the test conditions of paragraph 3.3 shall be selected.

When the vehicle provides multiple operating modes that are automatically selected by the vehicle, it is the responsibility of the manufacturer to determine the correct manner of testing to achieve the minimum sound emission.

In cases where it is not possible to determine the vehicle operating mode providing the lowest sound emission, all modes shall be tested and the mode giving the lowest test result shall be used to report the vehicle sound emission in accordance with this regulation.

3.2.4. Test mass of vehicle

Measurements shall be made on vehicles at mass in running order, as defined by the manufacturer, with an allowable tolerance of 15 percent.

Kommentar [A18]: The mass in running order is defined in para 2.16, not by the manufacturer

3.2.5. Tyre selection and condition

The tyres for test are selected by the vehicle manufacturer, and shall correspond to one of the tyre sizes and types designated for the vehicle by the vehicle manufacturer.

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

3.3. Operating conditions

3.3.1. General

For each operating condition, the vehicle can be tested either indoor or outdoor.

For constant speed and Reversing tests the vehicle may be tested either in motion or in simulated operating condition. For simulated vehicle operation, signals shall be applied to the vehicle to simulate actual in-use ~~signals~~operation.

If the vehicle is equipped with an internal combustion engine, it shall be turned off.

3.3.2. Constant speed tests

These tests are conducted with the vehicle in forward motion or with the vehicle speed simulated by an external signal and the vehicle in standstill condition.

3.3.2.1. Constant speed tests in forward motion

For a vehicle tested in an out-door facility, the path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test. The front plane of the vehicle shall pass from the line AA' at the start of the test and the rear plane of the vehicle shall pass from the line BB' at the end of the test, as shown on figure 1a. Any trailer, which is not readily separable from the towing vehicle, shall be ignored when considering the crossing of the line BB'. The vehicle shall maintain a constant test speed v_{test} when the front plane of the vehicle passes between AA' and BB'.

A vehicle tested in an indoor facility, shall be located with the front plane of the vehicle on the PP' line as shown in figure 2a. The vehicle shall maintain a constant test speed, v_{test} ~~during-for~~ at least 5 seconds.

For constant speed test condition of 10 km/h, the test speed v_{test} shall be 10 km/h \pm 2 km/h.

For constant speed test condition of 20 km/h, the test speed v_{test} shall be 20 km/h \pm 1 km/h

For automatic transmission vehicle, the gear selector shall be placed as specified by the manufacturer for normal driving.

For manual transmission vehicle, the gear selector shall be placed in the highest gear which can achieve the target vehicle speed with constant engine speed.

3.3.2.2. Constant speed simulated by an external signal and the vehicle in standstill condition

A vehicle tested in an indoor or outdoor facility, shall be located with the front plane of the vehicle on the PP' line as shown in figure 2b. The vehicle shall maintain a constant simulated test speed, v_{test} ~~during-for~~ at least 5 seconds.

For constant speed test condition of 10 km/h, the simulated test speed v_{test} shall be 10 km/h \pm [0,5] km/h.

For constant speed test condition of 20 km/h, the simulated test speed v_{test} shall be 20 km/h \pm [0,5] km/h

3.3.4. Reversing tests

The tests are realized either with the vehicle in rearward motion or at a standstill.

3.3.4.1. Reversing test in motion

For a vehicle tested in an out-door facility, the path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test. The rear plane of the vehicle shall pass from the line AA' at the start of the test and the rear plane of the vehicle shall pass from the line BB' at the end of the test, as shown on figure 1b. Any trailer, which is not readily separable from the towing vehicle, shall be ignored when considering the crossing of the line BB'. The vehicle shall maintain a constant test speed v_{test} when the rear plane of the vehicle passes between AA' and BB'.

A vehicle tested in an indoor facility, shall be located with the rear plane of the vehicle on the PP' line as shown in figure 2b. The vehicle shall maintain a constant test speed, v_{test} ~~during for~~ at least 5 seconds.

For constant speed test condition of 6 km/h, the test speed v_{test} shall be $6 \text{ km/h} \pm 2 \text{ km/h}$.

For automatic transmission vehicle, the gear selector shall be placed as specified by the manufacturer for normal reverse driving.

For manual transmission vehicle, the gear selector shall be placed in the highest reverse gear which can achieve the target vehicle speed with constant engine speed.

3.3.4.2. Reversing test simulated by an external signal and the vehicle in standstill condition

A vehicle tested in an indoor or outdoor facility, shall be located with the rear plane of the vehicle on the PP' line as shown in figure 2b. The vehicle shall maintain a constant simulated test speed, v_{test} during at least 5 seconds.

For constant test condition of 6 km/h, the simulated test speed v_{test} shall be $6 \text{ km/h} \pm [0,5] \text{ km/h}$.

3.3.4.3. Reversing test in standstill condition

A vehicle tested in an indoor or outdoor facility, shall be located with the rear plane of the vehicle on the PP' line as shown in figure 2b.

The vehicle's gear selection control shall be in the reverse position and the brake released for test.

3.4. Measurement readings and reported values

At least four measurements for each test condition shall be made on both sides of the vehicle.

The first four valid consecutive measurement results for each test condition, within 2,0 dB per side, allowing for the deletion of non-valid results, shall be used for the calculation of the intermediate or final result.

If a sound peak obviously out of character with the general sound pressure level is observed, that measurement shall be discarded. For measurement of a vehicle in motion (forward and Reversing) outdoor, the maximum A-weighted sound pressure level indicated during each passage of the vehicle between AA' and PP' ($L_{test,j}$) shall be noted for each microphone position, to the first significant digit after the decimal place (for example XX,X). For measurement of a vehicle in motion indoor and in standstill (forward and Reversing), the maximum A-weighted sound pressure level indicated during each period of 5 seconds define in paragraph xxx for each microphone position, $L_{test,j}$ shall be noted, to the first significant digit after the decimal place (for example XX,X).

$L_{test,j}$ shall be corrected according to paragraph 2.3.2 to obtain $L_{testcorr,j}$.

For each maximum A-weighted sound pressure level, the corresponding one-third-octave spectrum shall be reported for each microphone position. No background correction shall be applied to any measured one-third octave result.

3.5. Data compilation and reported results

For each test condition described in paragraph 3.3., the background corrected results, $L_{\text{test,corr},j}$, and the corresponding one third octave spectra of both sides of the vehicle for each individual test shall be arithmetic averaged separately. The average for both sides shall be rounded to the first decimal place.

The final A-weighted sound pressure level results $L_{\text{crs } 10}$, $L_{\text{crs } 20}$ and L_{back} to be reported are the lower values of the two averages of both sides, rounded to the nearest integer. The final one third octave spectra to be reported are the spectra corresponding to the same side as the reported A-weighted sound pressure level.

4. Test procedures for frequency shift

4.1 General

The provisions on frequency shift outlined in 6.2.3 of the main body shall be checked ~~by~~ using one of the following test methods to be selected by the manufacturer:

- Method (A) Test of the complete vehicle in motion on an outdoor test track
- Method (B) Test of the complete vehicle in standstill condition on an outdoor test track with simulation of the vehicle movement to AVAS by an external signal generator
- Method (C) Test of the complete vehicle in motion in an indoor facility on a Chassis Dynamometer.
- Method (D) Test of the complete vehicle in standstill condition in an indoor facility with simulation of the vehicle movement to AVAS by an external signal generator
- Method (E) Test of the AVAS without a vehicle in an indoor facility with simulation of the vehicle movement to AVAS by an external signal generator
- Method (F) Test of the AVAS with a vehicle in motion.

The facility requirements as well as the vehicle and test setup specifications are the same as given in paragraph 1, paragraph 2 and paragraphs 3.1 and 3.2 of this Annex 3 according to the selected test method unless the following paragraphs below provide different or additional specifications.

No background noise correction shall be applied to any measurement. Special care must be given for outdoor measurements. Any interference of the background noise shall be avoided. If a sound peak obviously out of character with the general signal is observed, that measurement shall be discarded.

4.2 Instrumentation and Signal processing

Analyser settings shall be determined by the user to provide data according to these requirements.

The sound analysis system shall be capable of performing spectral analysis at a sampling rate and over a frequency range containing all frequencies of interest. The frequency resolution shall be sufficiently precise to differentiate between the frequencies of the various test conditions.

4.3 Test methods

4.3.1 Method (A) – Outdoor facility and vehicle in motion

The vehicle shall be operated in the same outdoor test facility and according to the same general operating condition as for the vehicle constant speed testing (paragraph 3.3.2).

The vehicle sound emission shall be measured at target speeds of 5 km/h to 20 km/h in steps of 5 km/h with a tolerance of +/- 2 km/h for the speed of 10 km/h or less and of +/- 1 km/h for any other speeds. The speed of 5 km/h is the lowest target speed. If the vehicle cannot be operated at this speed within the given precision, the lowest possible speed below 10 km/h shall be used instead.

The same test prescriptions as of paragraph 3.3.2 shall be used.

4.3.2 Method (B) and Method (D) – Outdoor/Indoor facility and vehicle in standstill

The vehicle shall be operated in a test facility where the vehicle can accept an external vehicle speed signal simulating vehicle operation. The microphone locations shall be as for the complete vehicle test conditions as specified in Figure 1. The front plane of the vehicle shall be placed on line PP'.

The vehicle sound emission shall be measured at simulated speeds of 5 km/h to 20 km/h in steps of 5 km/h with a tolerance of +/- 0.5 km/h for each test speed.

4.3.3 Method (C) – Indoor facility and vehicle in motion

The vehicle shall be installed in an indoor test facility where the vehicle can operate on a chassis dynamometer in the same manner as outdoors. All microphone locations shall be as for the vehicle test conditions as specified in Figure 1. The front plane of the vehicle shall be placed on line PP'.

The vehicle sound emission shall be measured at target speeds of 5 km/h to 20 km/h in steps of 5 km/h with a tolerance of +/- 2 km/h for the speed of 10 km/h or less and of +/- 1 km/h for any other speeds. The speed of 5 km/h is the lowest target speed. If the vehicle cannot be operated at this speed within the given precision, the lowest possible speed below 10 km/h shall be used instead.

4.3.4 Method (E)

The AVAS shall be mounted rigidly in an indoor facility, by means of the equipment indicated by the manufacturer. The microphone of the measuring instrument shall be placed in 1 m distance from the AVAS in the direction where the subjective sound level is greatest and placed at a height of approximately the same level as the sound radiation of AVAS.

The sound emission shall be measured at simulated speeds of 5 km/h to 20 km/h in steps of 5 km/h with a tolerance of +/- 0.5 km/h for each test speed.

[4.3.5 Method (F)

To be developed if necessary.]

4.4. Measurement Readings and Signal Processing

4.4.1 Test Method (A)

At least [four] measurements shall be made at every speed specified in paragraph 4.3.1. The emitted sound shall be recorded during each passage of the vehicle between AA' and BB' for each microphone position. A correction for the Doppler effect may be applied, if needed. From each measurement sample a segment of +/- 1 second around the maximum sound level shall be cut out for further analysis.

(Signal to Noise ratio analysis)

4.4.2 Test Methods (B), (C), (D) and (E)

The emitted sound shall be measured at every speed specified in correlated paragraphs above for at least 5 seconds.

4.5 Signal Processing

For each recorded sample the autopower spectrum shall be determined, using a Hanning window and at least 66.6% overlap averages. The reported speed is the average of the speed during the time sample. In case of test method (A) the [four] determined spectra per test speed shall be energetically averaged. The resulting average spectrum per test speed shall be used for the further calculation. In all other cases the derived frequency spectrum shall directly be used for the further calculation. The reported speed is the average of the [four] measurements.

The spectrum of the lowest reported test speed is taken as the reference spectrum, of which a reference frequency $f_{i,ref}$ shall be identified. That frequency is intended to change as a function of vehicle speed. In case that more than one frequency is shifted, all frequencies shall be analysed in the way described below, however only one frequency shift needs to fulfil the requirements of 6.2.6.

For the other vehicle speeds, the corresponding shifted frequencies $f_{i,speed}$ shall be taken from the spectra analysis. Calculate del_f , the frequency shift of the signal according to equation (1):

$$del_f = \left\{ \frac{(f_{i,speed} - f_{i,ref})}{(v_{test} - v_{ref})} \right\} / f_{i,ref} \cdot 100 \quad \text{equation (1)}$$

where

- $f_{i,speed}$ is the frequency at a given speed value;
- $f_{i,ref}$ is the frequency at the reference speed of 5 km/h or the lowest reported speed;
- v_{test} is the vehicle speed, actual or simulated, corresponding to the frequency $f_{i,speed}$;
- v_{ref} is the vehicle speed, actual or simulated, corresponding to the frequency $f_{i,ref}$;

The results shall be reported using the following table 4:

Table 4 — Report table, to be completed for each frequency analysed

Target speed	Reported Speed (km/h)	Frequency, $f_{i,speed}$ (Hz)		Frequency Shift (%)
		Left Side	Right Side	
5 km/h (Reference)				n.a.
10 km/h				
15 km/h				
20 km/h				

Annex 3 - Appendix

Measuring positions for vehicles in motion

Figure 1a and 1b

Measuring positions for vehicles in motion out-door

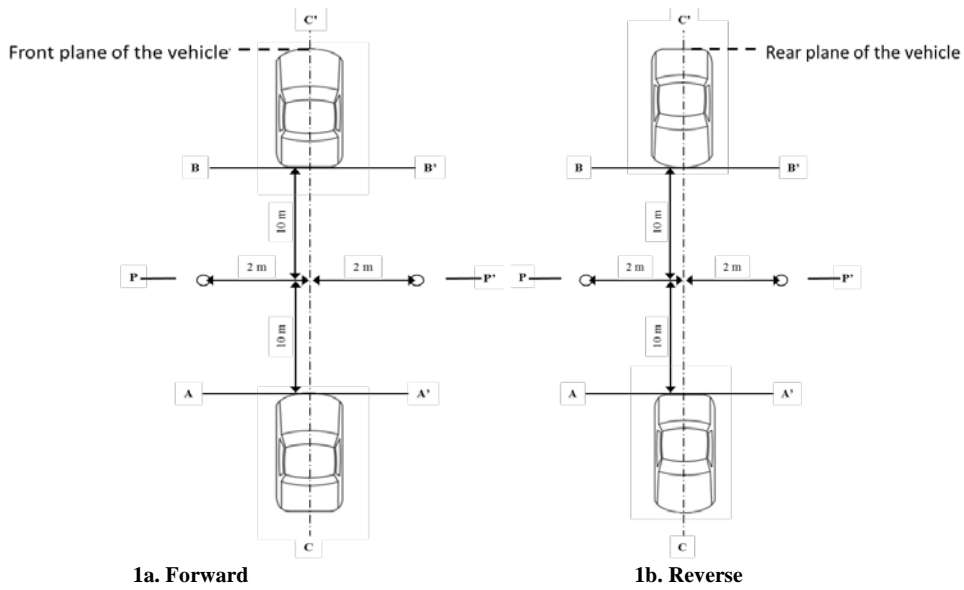
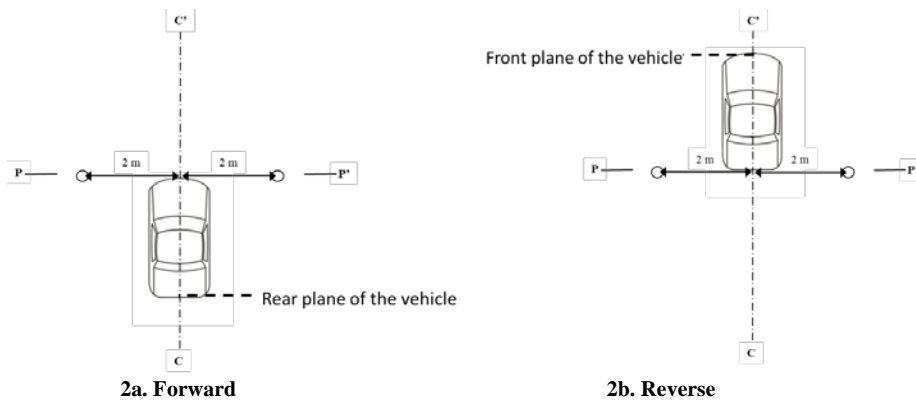


Figure 2a and 2b

Measuring positions for vehicles in motion in-door and in stationary



Background noise

Figure 3
Determination of the range of background noise