

ISO TC 43/SC 1 N

Date: 2002-12-13

ISO/CD 362

ISO TC 43/SC 1/WG 42

Secretariat: DS

Acoustics — Measurement of noise emitted by accelerating road vehicles - Engineering method

Acoustique — Mesurage du bruit émis par les véhicules routiers en accélération - Description de la méthode

Warning

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Document type: International Standard
Document subtype:
Document stage: (30) Committee
Document language: E

H:\Hubert\GRB\GRB informal group R41\02-R41WG-04.doc

Copyright notice

This ISO document is a working draft or committee draft and is copyright-protected by ISO. While the reproduction of working drafts or committee drafts in any form for use by participants in the ISO standards development process is permitted without prior permission from ISO, neither this document nor any extract from it may be reproduced, stored or transmitted in any form for any other purpose without prior written permission from ISO.

Requests for permission to reproduce this document for the purpose of selling it should be addressed as shown below or to ISO's member body in the country of the requester:

[Indicate the full address, telephone number, fax number, telex number, and electronic mail address, as appropriate, of the Copyright Manager of the ISO member body responsible for the secretariat of the TC or SC within the framework of which the working document has been prepared.]

Reproduction for sales purposes may be subject to royalty payments or a licensing agreement.

Violators may be prosecuted.

Contents

Page

Foreword	v
Introduction.....	vi
1 Scope	7
2 Normative references	7
3 Definitions	2
4 Symbols used.....	6
4.1 Symbols Used (update according to changes in 3.6).....	6
5 Instrumentation	8
5.1 Instruments for acoustical measurement	8
5.1.1 General	8
5.1.2 Calibration	8
5.1.3 Compliance with requirements	8
5.2 Instrumentation for speed measurements	8
5.3 Meteorological instrumentation	8
6 Acoustical environment, meteorological conditions and background noise	9
6.1 Test site	9
6.2 Meteorological conditions.....	9
6.3 Background noise.....	10
7 Test procedures	10
7.1 Microphone positions.....	10
7.2 Conditions of the vehicle	10
7.2.1 General Conditions.....	10
7.2.2 Test mass of the vehicle.....	10
7.2.3 Tyre selection and condition.....	11
7.3 Operating conditions	11
7.3.1 Category L	11
7.3.2 Category M1 and category N1 having a maximum authorized total mass not exceeding 2000kg.....	14
7.3.3 Vehicles category N1 having a maximum authorized total mass exceeding 2000kg	15
7.3.4 Vehicle of category M2, M3, N2, N3	16
7.4 Measurement readings and reported values	17
7.4.1 General	17
7.4.2 Vehicles of category L.....	17
7.4.3 Vehicles of category M1, N1.....	18
7.4.4 Vehicles of category M2, M3, N2, N3	19
7.5 Measurement uncertainty.....	19
8 Test report	19
Annex A (normative) Measurement uncertainty	21
Annex B (informative) Indoor test operation	22
B.1 Concept	22
B.2 Room Requirements	22
B.3 Dynamometer Requirement	22
B.4 Microphone Placement.....	23
B.5 Measurement Capability	23
B.6 Data Analysis	23
Annex C (informative) Technical background information	24

(informative) Flow chart of the procedure for vehicles of category M1 and N1.....	25
Bibliography	26

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for whom a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 362 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *and Noise*.

This fifth edition cancels and replaces the fourth edition (ISO 362: 1998). This document has been completely technically revised.

Introduction

The enclosed document is a working draft of the ISO working group WG42 on “measurement of noise emitted from accelerating road vehicles”. The committee has done an extensive review of actual in-use vehicle operations beginning with data from the TUV Automotive study in the early 1990's and has continued with data developed through other committee members in 1996 through 2000. It includes nearly 100 vehicles operated on a variety of urban roads in Europe and Asia. The primary focus of the in use measurements was to determine how vehicles are driven with a variety of vehicles, driving behaviours and traffic situations.

The procedure proposed here provides a measure of the sound level from vehicles under controlled and repeatable conditions. The definitions have been carried out according to the needs of vehicle categories. In cases of vehicles other than very heavy trucks and busses the committee found that attempts to conduct a partial load test as in actual use resulted in significant run to run variability that significantly interfered with the repeatability and reproducibility of the test cycle. Therefore the use of two primary operating conditions a wide open throttle acceleration phase and a constant speed phase guarantee simplicity and the combination was found to be equivalent to the partial throttle and partial power (engine load) actually used.

As a further consequence of the investigations about the needs for an efficient test, the committee concluded to design a test, which is independent of vehicle design and therefore safe and adaptable for future technologies, as well as, for future traffic conditions. The test guarantees an excitation of all relevant noise sources and the final test result will reflect a composition of these sources at a compromise between normal urban use and “worst case”.

In 1994, the International Motorcycle Manufacturers Association (IMMA) collected in-use data for vehicles of category L3 (two-wheeled motorcycles) to study rider attitude and behaviour. Additional in-use data was collected in 1999 and 2000 through a tripartite project in which the Dutch Ministry of the Environment (VROM), the Dutch research institute TNO-Automotive and IMMA took part. Though the aim of this project was to collect data with which to construct a motorcycle specific exhaust emissions test cycle for motorcycles, the data was considered equally suitable as basis for the definition of a more representative urban noise test procedure. From 2002 to 2004, additional in-use data for low performance motorcycles was added to enhance the coverage of the database.

The measurement procedure contained in ISO 362:1998 for categories L4 and L5 is maintained until data for these categories becomes available.

This test was developed under the demands on a new test procedure:

“The test procedure (ISO R 362) doesn't reflect realistic driving conditions “ 1996 EU Green Paper

“In the case of motor vehicles other factors are also important such as the dominance of tyre noise above quite low speeds (50 km/h)” - 1996 EU Green Paper

“A new measurement procedure ... should require that the major noise sources of a vehicle be measured” – 2001 Noise Emission of Road Vehicles – I-INCE

Acoustics — Measurement of noise emitted by accelerating road vehicles - Engineering method

1 Scope

This International Standard specifies an engineering method for measuring the noise emitted by road vehicles under typical urban traffic conditions, excluding vehicles of category L1 and L2 (see clause 3.5), which are covered by ISO 9645.

The specifications are intended to reproduce the noise levels, which are generated, by the principal noise sources during normal driving in urban traffic. (See Annex C - Technical Background).

The method is designed to meet the requirements of simplicity as far as they are consistent with reproducibility of results under the operating conditions of the vehicle.

The test method requires an acoustical environment, which can only be obtained in an extensive open space. Such conditions can usually be provided for:

- type approval measurements of vehicle
- measurements at the manufacturing stage
- measurements at official testing stations

NOTE 1: The results obtained by this method give an objective measure of the noise emitted under the specified conditions of test. It is necessary to consider the fact that the subjective appraisal of the noise annoyance of different classes of motor vehicles is not simply related to the indications of a sound measurement system. As annoyance is strongly related to personal human perception, physiological human condition, culture, environmental condition there is a large variation and therefore not useful as a parameter to describe a specific vehicle condition.

NOTE 2: It should be noted that spot-checking of vehicles chosen at random can rarely be made in an ideal acoustical environment. If measurements have to be carried out on the road in an acoustical environment, which does not fulfil the requirements stated in this International Standard, it should be recognised that the results obtained may deviate appreciably from the results obtained using the specified conditions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10844:1994, *Acoustics - Test surface for road vehicle noise measurements*

IEC 61672-1:2002, *Electro acoustics Sound level meters part 1*

IEC 60942:2003, *Electro acoustics Sound calibrators*

ISO 1176 :1990 *Road vehicles – masses - vocabulary and codes*

ISO 1585:1992, *Road vehicles -- Engine test code -- Net power*

ISO 6726 *Mopeds and Motorcycles with two wheels – Masses – Vocabulary*

ISO 4106 *Motorcycle – Engine test code – net power*

ISO 9645 *Acoustics - Measurement of noise emitted by two-wheeled mopeds in motion - Engineering method*

[Guide to the Expression of Uncertainty in Measurement, International Organisation for Standardisation \(ISO\), Geneva \(CH\), 1995, ISBN 92-67-101889](#)

3 Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 automatic downshift

gear change to a lower gear (higher transmission ratio), which can be initiated directly or indirectly at the will of the driver

NOTE: An automatic downshift may be initiated, for example, by a change of pressure on or position of the accelerator control, thereby activating a special program, which effects downshifts to gears that are lower than those normally used in urban driving.

3.2 kerb mass

complete shipping mass of a vehicle 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 % 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.

NOTE: The definition of kerb mass may vary from country to country, but in this standard it refers to the definition contained in ISO 1176 and ISO 6726.

3.3 maximum authorized mass

The maximum authorized mass is defined as the kerb mass plus the maximum allowable payload

3.4 power to mass ratio index

The power to mass ratio index is defined as:

$$\text{PMR} = P_n / m_t * 1000 \text{ kg/kW}$$

Equation 3.4-1

Note: The Power to mass ratio index (PMR) is used in this standard for the calculation of acceleration. By definition PMR is a numerical quantity with no dimensions.

3.5 rated engine speed, S

engine speed at which the engine develops its rated maximum net power as stated by the manufacturer. If the rated maximum net power is reached at several engine speeds, use the highest engine speed.

3.6 vehicle categories

3.6.1 category L, motor vehicles with fewer than four wheels

L1 and L2: mopeds (see ISO 9645 for further details),

L3: two wheeled motor vehicles with an engine cylinder capacity $> 50 \text{ cm}^3$ or maximum speed $> 50 \text{ km/h}$,

L4: three wheeled motor vehicles with an engine cylinder capacity $> 50 \text{ cm}^3$ or maximum speed $> 50 \text{ km/h}$, the wheels being attached asymmetrically along the longitudinal vehicle axis,

L5: three wheeled motor vehicles with an engine cylinder capacity $> 50 \text{ cm}^3$ or maximum speed $> 50 \text{ km/h}$, having a gross vehicle mass rating $< 1000 \text{ kg}$ and wheels attached symmetrically along the longitudinal vehicle axis.

3.6.2 category M, motor vehicles with at least four wheels used for the carriage of passengers

M1: vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat,

M2: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5000 kg,

M3: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5000 kg.

3.6.3 category N, motor vehicles with at least four wheels used for the carriage of goods

N1: vehicles used for the carriage of goods and having a maximum authorized total mass not exceeding 3500 kg,

N2: vehicles used for the carriage of goods and having a maximum authorized total mass exceeding 3500 kg tonnes but not exceeding 12000 kg,

N3: vehicles used for the carriage of goods and having a maximum authorized total mass exceeding 12000 kg

3.7 reference point

depending on the design of the vehicle the following definitions for the reference point shall be used:

3.7.1 category L

The reference point is the front end of the vehicle.

3.7.2 category M1, N1

for front engine vehicles the reference point is the front end of the vehicle

for mid engine vehicles the reference point is the centre of the vehicle

for rear engine vehicles the reference point is the rear end of the vehicle

3.7.3 category M2, M3, N2, N3

The reference point is the border of the engine closest to the front of the vehicle

3.8 acceleration

all accelerations in this paper are calculated using different speeds of the vehicle on the test track. The formulas given are used for the calculation of $a_{wot\ i}$, $a_{wot\ i+1}$ and $a_{wot\ test}$. The speed either at AA' or PP' is defined by the vehicle speed when the reference point passes AA' or PP'. The speed at BB' is defined when the rear of the vehicle passes BB'. The method used for determination of the acceleration shall be indicated in the test report

Due to the definition of the reference point for the vehicle the length of the vehicle is considered different in the formula below. If the reference point is in the front of the vehicle, the $l = l_{veh}$ is the length of vehicle, mid: $l = \frac{1}{2} l_{veh}$ is $1/2 \times$ length of vehicle and rear: $l = 0$

NOTE 1: Due to the large variety of technologies it is necessary to consider different modes of calculation. Especially very new technologies like continuously variable transmission and older technologies, like automatic transmission, which have no electronic control, require a more specific treatment for a proper determination of the acceleration. The given possibilities for calculation of the acceleration shall cover these needs. (However a revision of this paragraph is necessary during the next update of this standard.)

3.8.1 Vehicles of category **L**, M and N

3.8.1.1 calculation procedure for vehicles with manual transmission, automatic transmission, adaptive transmission and CVT with lockable gear ratios

$$a_{\text{wot}} = ((v_{\text{BB}}/3.6)^2 - (v_{\text{AA}}/3.6)^2) / (2 \cdot (20 + I)) \quad \text{Equation 3.8-2}$$

NOTE 1: to achieve a stabilized acceleration pre-acceleration may be used.

3.8.1.2 calculation procedure for vehicles with automatic transmission, adaptive transmission and CVT with non lockable gear ratios

$$a_{\text{wot}} = ((v_{\text{BB}}/3.6)^2 - (v_{\text{PP}}/3.6)^2) / (2 \cdot (10 + I)) \quad \text{Equation 3.8.3}$$

Pre-acceleration shall not be used.

NOTE 1: for these type vehicles, vehicle speeds shall be recorded at AA, PP, and BB to provide information for future revision of this standard.

3.9 target acceleration

The target acceleration a_{urban} defines the typical acceleration in urban traffic and is derived from statistical investigations. It is a function depending on the power-to-mass ratio of a vehicle. That function is different for specific vehicle categories.

3.9.1 category **L**

$$a_{\text{urban}} = 0.80 \cdot \log(\text{PMR}) - 0.20 \quad \text{for } 25 < \text{PMR} \leq 50 \quad \text{Equation 3.9-1}$$

$$a_{\text{urban}} = 1.03 \cdot \log(\text{PMR}) - 0.64 \quad \text{for } \text{PMR} > 50 \quad \text{Equation 3.9-2}$$

3.9.2 category M1M2 having a maximum authorized mass not exceeding 3500 kg, N1

$$a_{\text{urban}} = 0.63 \cdot \log(\text{PMR}) - 0.09 \quad \text{Equation 3.9-2}$$

3.9.3 category M2 having a maximum authorized mass exceeding 3500 kg, M3, N2, N3

no curve is provided for the test of these vehicle categories.

3.10 reference acceleration

the reference acceleration $a_{\text{wot ref}}$ defines the required acceleration during the accelerated test on the test track. It is a function depending on the power-to-mass ratio of a vehicle. That function is different for specific vehicle categories

3.10.1 vehicles category L

$$a_{\text{wot ref}} = 2.47 * \log(\text{PMR}) - 2.52 \quad \text{for } 25 < \text{PMR} \leq 50 \quad \text{Equation 3.10-1}$$

$$a_{\text{wot ref}} = 1.99 * \log(\text{PMR}) - 1.83 \quad \text{for } \text{PMR} > 50 \quad \text{Equation 3.10-2}$$

3.10.2 vehicles category M1, M2 having a maximum authorized mass not exceeding 3500 kg, N1

$$a_{\text{wot ref}} = 1.59 * \log(\text{PMR}) - 1.41 \quad \text{for } 25 \leq \text{PMR} \quad \text{Equation 3.10-2}$$

$$a_{\text{wot ref}} = a_{\text{urban}} = 0.63 * \log(\text{PMR}) - 0.09 \quad \text{for } 25 > \text{PMR} \quad \text{Equation 3.10-3}$$

3.10.3 vehicles category M2 having a maximum authorized mass exceeding 3500 kg, M3, N2, N3

No curve is provided for the test of these vehicle categories

3.11 partial power factor k_P

partial power factor k_P is used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles of category L, M1 and N1. In case other than a single gear test $a_{\text{wot ref}}$ has to be used instead of $a_{\text{wot test}}$ (see also 7.4.5)

$$k_P = 1 - (a_{\text{urban}} / a_{\text{wot test}}) \quad \text{Equation 3.11-1}$$

4 Symbols used

4.1 Symbols Used

Symbol	Unit	Clause	Explanation
$V_{AA'}$	km/h	3.8	vehicle speed at the approach of AA'
$V_{BB'}$	km/h	3.8	vehicle speed at the end of the test track
$V_{PP'}$	km/h	3.8	vehicle speed at PP'
V_{max}	km/h		maximum vehicle speed as declared by the manufacturer
V_{test}	km/h	3.6	Vehicle test
$n_{AA'}$	1/min	7.3.4	engine rotation speed of the vehicle, when the reference point passes AA'
$n_{BB'}$	1/min	7.3.4	engine rotation speed of the vehicle, when the reference point passes BB'
S	1/min	7.3.4	rated engine speed in rpm, synonymous with the engine speed at maximum power
P_n	kW	3.5	rated engine power (ISO 1585:1992; ISO 4106)
m_t	kg	7.2.2	test mass of the vehicle
m_{kerb}	kg	3.2	kerb mass of the vehicle
m_{ref}	kg	7.2.2	kerb mass + 75 kg for the driver (75 ± 5 kg in case of category L)
PMR	-	3.9	power to mass ratio index to be used for calculations
l	m	3.8	reference length
l_{veh}	m	3.8	length of vehicle
$L_{wot rep}$	dB	7.4.3	reported vehicle noise at wide open throttle
L_{wot}	dB	7.4.2	vehicle noise at wide open throttle
$L_{crs rep}$	dB	7.4.3	reported vehicle noise at constant speed test
L_{crs}	dB	7.4.2	vehicle noise at constant speed test

$a_{\text{wot ref}}$	m/s^2	3.7	reference acceleration rate for the wide open throttle test
$a_{\text{wot } i}$	m/s^2	3.5	acceleration at wide open throttle in gear i
$a_{\text{wot } i+1}$	m/s^2	3.5	acceleration at wide open throttle in gear $i+1$
$a_{\text{wot test}}$	m/s^2	3.5	acceleration at wide open throttle in single gear test cases
a_{urban}	m/s^2	3.6	target acceleration respective urban traffic acceleration
gear i		7.3.2.3.1	the first of two gear ratio for use in the vehicle test
gear $i+1$		7.3.2.3.1	the second of two gear ratio with an engine speed lower than gear ratio i
k_P		3.8	partial power factor
k		7.3.2.3.1	gear weighting factor

5 Instrumentation

5.1 Instruments for acoustical measurement

5.1.1 General

The apparatus used for measuring the sound level must be a precision sound-level meter or equivalent measurement system meeting the requirements of Type 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in "IEC 61672-1:2002: Precision sound level meters", second edition, of the International Electrotechnical Commission (IEC).

The entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of precision Class 1 according to IEC 60942:2003.

Measurements shall be carried out using the "fast" response of the acoustic measurement instrument and the "A" weighting curve also described in IEC 61672-1:2002. 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.

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

5.1.2 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 5.1.1. 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.

5.1.3 Compliance with requirements

Compliance of the sound calibration device, with the requirements of IEC 60942:2003, shall be verified once a year. Compliance of the instrumentation system, with the requirements of IEC 61672-1:2002, shall be verified at least every 2 years. All compliance testing must be conducted by a laboratory, which is authorized to perform calibrations traceable to the appropriate standards.

5.2 Instrumentation for speed measurements

The rotational speed of the engine shall be measured with instruments meeting specification limits of $\pm 2\%$ or better.

The road speed of the vehicle shall be measured with instruments meeting specification limits of ± 0.5 km/h or better.

If testing is performed only in one direction, using independent measurements of speed, this instrumentation must meet specification limits of ± 0.2 km/h.

5.3 Meteorological instrumentation

The required accuracy for 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
- $\pm 5\%$ for a relative humidity measuring device

6 Acoustical environment, meteorological conditions and background noise

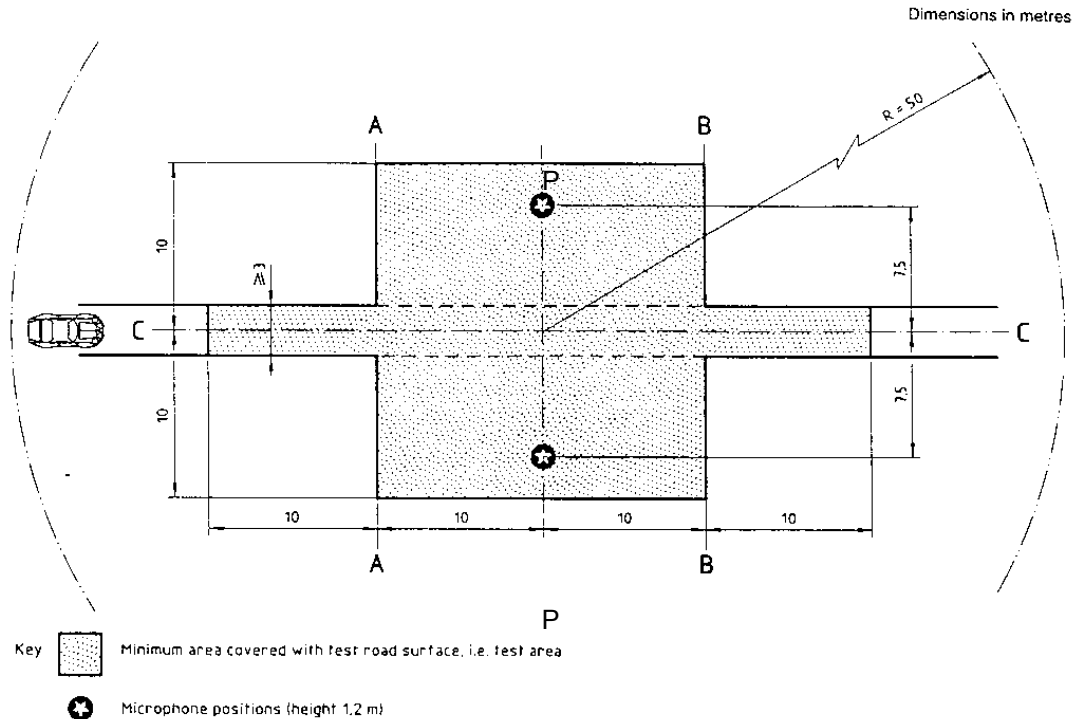
6.1 Test site

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

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 microphone, there shall be no obstacle that could influence the acoustical 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.

NOTE Buildings outside the 50 m radius might have reasonable influence if their reflection focuses on



NOTE Shaded area ("test area") is the minimum area to be covered with a surface complying with ISO 10844.

the test track.

Figure 1: Test site dimensions

6.2 Meteorological conditions

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

The measurements shall be made when the ambient air temperature is within the range from 5 °C to 40 °C. The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.

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

NOTE: Refer to Annex A for the effects of temperature and other factors.

6.3 Background noise

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

The background noise shall be measured for duration of 10sec immediately before and after a series of vehicle tests. The maximum noise level shall be reported as the background noise level. The background noise level is defined as the maximum noise level during these measurements of background noise.

7 Test procedures

7.1 Microphone positions

The distance from the microphone positions on the microphone line PP', perpendicular to the reference line CC' (see Figure 1) on the test track shall be 7,5 m ± 0,05 m.

The microphone shall be located 1,2 m ± 0,02 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 must be done before and after a test session. Results shall be refused, if the values have a variation of more than 0,5 dB.

7.2 Conditions of the vehicle

7.2.1 General Conditions

The vehicle shall be supplied as specified by the vehicle manufacturer.

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

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

7.2.2 Test mass of the vehicle

Measurements shall be made on vehicles at the test mass m_t specified according to table 7.2.2.

Vehicle Category	Vehicle Test Mass
L, M1	$m_t = m_{ref} = m_{kerb} + 75\text{kg}$ for the driver (75±5kg for category L)
N1<=2500kg Authorized total mass	$m_t = m_{ref} = m_{kerb} + 75\text{kg}$ for the driver
N1>2500kg	

Authorized total mass	$m_t = m_{\text{kerb}} + 75\text{kg}$ for the driver + payload (which is 50% of max payload –75kg)
N2, N3	<p>$m_t = 50 \text{ kg per kW}$ rated power</p> <p>Extra loading to reach the test mass of the vehicle shall be placed above the rear axle. The extra loading is limited to 75% of the maximum mass allowed for the rear axle. The test mass must be achieved with a tolerance of +/-5%.</p> <p>If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass of the vehicle shall not exceed the sum of the front axle and the rear axle load in un-laden condition plus the extra loading.</p> <p>The total mass for vehicles with more than two axles shall be the same as for a two-axle vehicle.</p>
M2, M3	$m_t = m_{\text{kerb}} + 75\text{kg}$ for the driver

Note: N1 Category vehicles may be loaded, at the decision of the vehicle manufacturer for practical reasons during the test. This practice is acceptable, however may lead to higher vehicle noise levels (typically +1.0 dBA). If load is added to these vehicles during testing the added payload shall be noted in the test report.

7.2.3 Tyre selection and condition

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

NOTE 1 The tread depth can have a significant influence on the test result.

NOTE 2 For type approval and conformity of production purposes additional requirements for the tyres are necessary and should be defined by a regulation. This standard recommends that the tyres for such a test shall be selected by the vehicles manufacturer. They shall correspond to one of the tyre size and type designated for the vehicle by the vehicle manufacturer. The tyre is or will be commercially available on the market at the same time as the vehicle. The minimum tread depth shall be at least 80% of the full tread depth.

7.3 Operating conditions

7.3.1 Category L

7.3.1.1 Category L3 with PMR > 25

7.3.1.1.1 General conditions

The vehicle shall approach the line AA' with the path of its centreline following as closely as possible the line CC' (see Figure 1).

If the vehicle is fitted with an auxiliary manual transmission the position used for normal urban driving shall be used.

7.3.1.1.2 Test speed

The test speed v_{test} shall be:

$$\begin{aligned} &40 \text{ km/h} \pm 1 \text{ km/h} \quad \text{for } 25 < \text{PMR} \leq 50 \\ &50 \text{ km/h} \pm 1 \text{ km/h} \quad \text{for } \text{PMR} > 50 \end{aligned}$$

The test speed must be reached, when the reference point according to 3.7.1 passes line PP'. The test speed shall be reduced by increments of 10% of V_{PP} in case the exit speed V_{BB} exceeds 75% of V_{max} .

Note: The test speed v_{test} can be approximated with an entry speed V_{AA} , calculated by using the formula

$$V_{\text{AA}} = (v_x - v_k) \text{ km/h} \pm 1 \text{ km/h}$$

In which:
$$v_k = v_x - (v_x^2 - a_{\text{wot.ref}} * 20 * 3.6^2)^{1/2}$$

Where:
$$\begin{aligned} v_x &= 40 \text{ for } 25 < \text{PMR} \leq 50 \\ v_x &= 50 \text{ for } \text{PMR} > 50 \end{aligned}$$

7.3.1.1.3 Gear selection

7.3.1.1.3.1 Manual transmission

The intended gear ratio to be selected shall be the one, which gives during the acceleration test an acceleration calculated according to 3.8.1 that is within a tolerance band of $\pm 10\%$ of the reference acceleration. In case no gear ratio exists within this tolerance band, two gear ratios shall be selected, being gear ratio i , with an acceleration higher and the gear ratio $i+1$, with an acceleration lower than the reference acceleration. The weighting ratio in relation to the reference acceleration $a_{\text{wot.ref}}$ is calculated by:

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

In case there are two gears which lie within the tolerance band, the weighting ratio shall be calculated as shown above.

The reference acceleration is specified in 3.10.1. If the rated engine speed is exceeded during the test, the gear ratio to be used shall be the highest one without exceeding rated engine speed unless there is no other higher gear available.

7.3.1.1.3.2 Automatic transmission

The gear selector position for normal urban driving shall be used. The test may then include a gear change to a lower range and a higher acceleration. However a gear shifting to a gear ratio, which is not used in urban traffic, shall be avoided. Therefore it is permitted to establish and use electronic or mechanic devices. But all other conditions shall be met.

Note: Gear selector position for normal urban driving means D-range

7.3.1.1.3.3 Adaptive transmissions and transmissions with variable gear ratio

To ensure the reproducibility it is permitted to establish and use electronic or mechanic devices to lock a gear ratio according to normal urban use.

7.3.1.1.4 Acceleration test

The acceleration test shall be carried out for all gear ratios specified in 7.3.1.1.3 and with the test speed as specified in 7.3.1.1.2. The acceleration control unit shall be fully engaged as quickly as practically possible (without operating the automatic downshift to a lower range than normally used in urban driving) when the reference point reaches AA' and kept in that position until the rear of the vehicle reaches BB'. The acceleration control unit must then be released as quickly as possible.

7.3.1.1.5 Constant speed test

The constant speed test shall be carried out with the same gear ratios as for the acceleration test specified in 7.3.1.1.4 and with the test speed as specified in 7.3.1.1.2. During the constant speed test the acceleration control unit shall be positioned to maintain the test speed between AA' and BB' or the vehicle speed at PP' during the acceleration test in case of vehicles with reduced entry speed V_{AA} to ensure that V_{BB} does not exceed 75% of V_{max} . The tolerance on the test speed shall be ± 1 km/hr

7.3.1.2 Category L3 with $PMR \leq 25$

For category L3 vehicles with $PMR \leq 25$, the operating condition consists of an acceleration test only. The general conditions specified in 7.3.1.1.1 shall apply.

The initial test speed shall be as specified in 7.3.1.1.2. The test speed shall be reduced by increments of 10% in case the exit speed V_{BB} exceeds 75% of V_{max} . The selected gear ratio shall be the lowest one without exceeding the rated engine speed S during the test. The final test conditions are determined by the lowest possible gear at the highest possible test speed without exceeding 75% of V_{max} and the rated engine speed at BB'.

7.3.1.3 Category L4 and L5

For category L4 and L5 vehicles, the operating condition consists of an acceleration test only.

7.3.1.3.1 Automatic transmission

7.3.1.3.1.1 Approach speed

The vehicle shall approach the line AA at a constant speed corresponding to the lower of the following speeds:

- a) 50 km/h;
- b) the vehicle speed corresponding to an engine speed equal to 75% of S .

if there is a downshift to first gear during the test, the motorcycle speed can be increased up to a maximum of 60 km/h to avoid the downshift.

7.3.1.3.1.2 Choice of gear ratios

The test shall be performed with the manual selector in the highest position. If an automatic downshift occurs to the first gear, it shall be excluded. If an automatic downshift occurs to the highest minus 1 or the highest minus 2, the selector shall be placed in the highest position allowing the test to be performed without an automatic downshift.

If an electronic transmission cannot be tested, a programme shall be established and used that prevents a downshift to a gear not normal for urban driving.

7.3.1.3.2 Motorcycle with a manually operated gearbox

7.3.1.3.2.1 Approach speed

The vehicle shall approach the line AA at a constant speed corresponding to the lower of the following speeds:

- a) 50 km/h,
- b) the vehicle speed corresponding to an engine speed equal to 75% of S.

7.3.1.3.2.2. Choice of gear ratios

Motorcycles fitted with a gearbox having not more than four gears, shall be tested in second gear. If the engine speed at the line BB exceeds S, test in the next higher gear.

Motorcycles fitted with a five-speed or more gearbox shall be tested in the following gears:

- a) Motorcycles fitted with an engine having a cylinder capacity not exceeding 175 cm³ shall be submitted to one test only in third gear.
- b) Motorcycles fitted with an engine having a cylinder capacity exceeding 175 cm³ shall be tested in second gear then in third gear.
- c) If the engine speed at the line BB exceeds S, test only in third gear.

7.3.1.3.3 Other automatic transmissions

Motorcycles without a manual selector shall approach the line AA at the various uniform speeds of 30 km/h, 40 km/h, and 50 km/h or at 75% of V_{\max} if this value is lower.

7.3.2 Category M1, M2 having a maximum authorized mass not exceeding 3500kg, N1

7.3.2.1 General conditions

The vehicle shall approach AA' with the path of its centreline following as closely as possible CC' (see Figure 1). Any trailer, which is not readily separable from the towing vehicle, shall be ignored when considering the crossing of the line BB'. If the vehicle is fitted with more than two-wheel drive, test it in the drive selection that is intended for normal road use. 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.

7.3.2.2 Test speed

The test speed v_{test} is 50km/h \pm 1km/h. The test speed must be reached, when the reference point according to 3.5.2 is at line PP'.

7.3.2.3 Gear ratio selection

7.3.2.3.1 Manual transmission

The selection of gear ratios for the test depends on their specific acceleration potential a_{wot} under full throttle condition according to the specification in 3.6 in relation to the reference acceleration $a_{\text{wot ref}}$ required for the full throttle acceleration test according to equation 3.8.2.

The following conditions for selection of gear ratios are possible:

- if one specific gear ratio gives acceleration in a tolerance band of $\pm 5\%$ of the reference acceleration $a_{\text{wot ref}}$, test with that gear ratio.
- 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 $i+1$ does not exceed 2.0 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:

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

-
- if the acceleration value of gear ratio i or $i+1$ exceeds 2.0 m/s^2 , the first gear ratio shall be used that gives an acceleration below 2.0 m/s^2 . 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 $a_{\text{wot ref}}$.
- If the vehicle has a transmission in which there is only one selection for the gear ratio the full throttle test is carried out in this vehicle gear selection. The achieved acceleration is then used for the calculation of the part power factor k_P (see 3.9) instead of $a_{\text{wot ref}}$.
- if rated engine speed is exceeded in a gear ratio before the vehicle passes BB' the next higher gear shall be used.

7.3.2.3.2 Automatic transmission, Adaptive transmissions and transmissions with variable gear ratios

The gear selector position for normal urban driving shall be used. The test may then include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. In any case, a gear shifting to a gear ratio which is not used in urban traffic, shall be avoided. An acceleration value greater than 2.0 m/s^2 shall be avoided. It is permitted to establish and use electronic or mechanical devices to lock a gear ratio according to normal urban use. But all other conditions shall be met. The achieved acceleration is then used for the calculation of the part power factor k_P (see 3.9) instead of $a_{\text{wot ref}}$.

7.3.2.4 Acceleration test

The acceleration test shall be carried out in all gear ratios specified for the vehicle according to 7.3.2.3 with the test speed specified in 7.3.2.2.

When the front of the vehicle reaches the AA' the acceleration control unit shall be fully engaged and held fully engaged until the rear of the vehicle reaches BB'. The acceleration control unit shall then be released. Pre-acceleration may be used if acceleration is delayed beyond AA'. The location of the start of the acceleration shall be reported.

7.3.2.5 Constant speed test

The constant speed test is not required for vehicles with a PMR < 25.

The constant speed test shall be carried out with the same gears specified for acceleration test in 7.3.2.3.

During the constant speed test the acceleration control unit shall be positioned to maintain a constant speed between AA' and BB' of 50 km/hr \pm 2 km/hr and shall be 50 km/hr \pm 1 km/hr at PP'.

7.3.3 Vehicle of category M2 having a maximum authorized mass exceeding 3500kg, M3, N2, N3

7.3.3.1 General conditions

The vehicle shall approach the line AA' with the path of its centreline following as closely as possible the CC' (see figure 1). The test must be conducted without a trailer or semi-trailer. If a trailer is not readily separable from the towing vehicle it shall be ignored when considering the crossing of line BB'. If the vehicle incorporates equipment such as a concrete mixer, a compressor, etc, this equipment shall not be in operation during the test. The test mass of the vehicle including the test payload shall be according to 7.2.2.

7.3.3.2 Target conditions

7.3.3.2.1 Category M2 having a maximum authorized mass exceeding 3500kg, N2

When the reference point passes BB', the engine revolution $n_{BB'}$ shall be between 70 per cent and 74 per cent of speed S, at which the engine develops its rated maximum power, and the vehicle test speed v_{test} shall be 35 km/h \pm 5 km/h.

7.3.3.2.2 Category M3, N3

When the reference point passes BB', the engine revolution $n_{BB'}$ shall be between 85 per cent and 89 per cent of speed S, at which the engine develops its rated maximum power, and the vehicle test speed v_{test} shall be 35 km/h \pm 5 km/h.

7.3.3.3 Gear selection

7.3.3.3.1 Manual transmission

Stable acceleration condition must be ensured. The gear choice is determined by the target conditions.

If more than one gear fulfils the target conditions take that gear which is closest to 35km/h. If no single transmission gear fulfils the target condition for v_{test} , then two gears shall be tested, one above and one below v_{test} . The target engine speed shall be reached in any condition.

A stable acceleration condition must be ensured. If a stable acceleration cannot be ensured in a gear, this gear has to be disregarded.

7.3.3.3.2 Automatic transmission, Adaptive transmissions and transmissions with variable gear ratio

The gear selector position for normal urban driving shall be used. The test may then include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. A gear change to a gear ratio, which is not used in urban traffic, shall be avoided. It is permitted to establish and use electronic or mechanic devices to lock a gear ratio according to normal urban use.

If the vehicle includes a transmission design, which provides only a single gear selection (D), which limits engine speed during the test, the vehicle shall be tested using only a target vehicle speed. The target vehicle speed for the test is $v_{\text{BB}} = 35 \text{ km/h} \pm 5 \text{ km/h}$. A gear change to a higher range and a lower acceleration is allowed after the vehicle passes line PP. Two tests must be performed, one with the end speed of $v_{\text{test}} = v_{\text{BB}} + 5 \text{ km/h}$, and one with the end speed of $v_{\text{test}} = v_{\text{BB}} - 5 \text{ km/h}$. The reported sound level is that result which is related to the test with the highest engine speed obtained during the test from AA to BB.

7.3.3.4 Wide open throttle test

When the reference point of the vehicle reaches the AA' the acceleration control unit shall be fully engaged and held fully engaged until the rear of the vehicle passes BB', but the reference point shall be at least 5 m behind BB'. The acceleration control unit shall then be released.

7.4 Measurement readings and reported values

7.4.1 General

At least four measurements for all test conditions shall be made on each side of the vehicle and for each gear ratio.

The maximum A-weighted sound pressure level indicated during each passage of the vehicle between AA' and BB' (see figure 1) shall be noted, to the first significant digit after the decimal

place (for example - XX.X). If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded.

The first four valid consecutive measurement results, within 2,0 dB, allowing for the deletion of non-valid results (sub-clause 6.2), shall be used for the calculation of the final result.

7.4.2 Data compilation

For a given test condition the results of each side of the vehicle shall be averaged separately. The intermediate result is the higher value of the two averages mathematically rounded to the first decimal place.

All further calculation to derive L_{urban} shall be done separately for the left and right vehicle side. The final value to be reported as the test result is the higher value of the two sides.

7.4.3 Vehicles of category L

7.4.3.1 Vehicles of category L3 with PMR > 25

The provisions of 7.4.4 and 7.4.5 shall apply.

7.4.2.2 Vehicles of category L3 with PMR ≤ 25

The final reported value shall be the intermediate result.

7.4.2.3 Vehicles of category L4 and L5

The final reported value for the vehicle shall be as indicated below:

- a) For vehicles tested in a single gear: the intermediate result.
- b) For vehicles tested in two gears: the arithmetic average of the intermediate results for each gear.

7.4.4 Vehicles of category M1, M2 having a maximum authorized mass not exceeding 3500kg, N1

The acceleration for further use is the average acceleration of the four runs.

$$a_{wot, test} = 1/4 * (a_{wot, test(1)} + a_{wot, test(2)} + a_{wot, test(3)} + a_{wot, test(4)})$$

Equation 7.4.4-1

where the numbers in brackets symbolize the test runs.

7.4.5 Vehicles of category M1, M2 having a maximum authorized mass not exceeding 3500kg, N1

The calculated reporting value $L_{wot rep}$ for the wide open throttle test is

$$L_{wot rep} = L_{wot (i+1)} + k * (L_{wot(i)} - L_{wot (i+1)})$$

Equation 7.4.5-1

The calculated reporting value $L_{\text{crs rep}}$ for the constant speed test is:

$$L_{\text{crs rep}} = L_{\text{crs}(i+1)} + k * (L_{\text{crs}(i)} - L_{\text{crs}(i+1)}) \quad \text{Equation 7.4.5-2}$$

In case of a single gear ratio test the reporting values are directly derived from the test result itself.

The final result is calculated by combining $L_{\text{wot rep}}$ and $L_{\text{crs rep}}$

The equation is:

$$L_{\text{urban}} = L_{\text{wot}} - k_P * (L_{\text{wot rep}} - L_{\text{crs rep}}) \quad \text{Equation 7.4.5-3}$$

The weighting factor k_P gives the part power factor for urban driving. In cases other than a single gear test k_P is calculated by

$$k_P = 1 - (a_{\text{urban}} / a_{\text{wot ref}}) \quad \text{Equation 7.4.5-4}$$

If only one gear was specified for the test k_P is given by

$$k_P = 1 - (a_{\text{urban}} / a_{\text{wot test}}) \quad \text{Equation 7.4.5-5}$$

In cases where $a_{\text{wot test}}$ is less than a_{urban} :

$$k_P = 0 \quad \text{Equation 7.4.5-6}$$

7.4.6 Vehicles of category M2 having a maximum authorized mass exceeding 3500kg, M3, N2, N3

When one gear is tested the final result is the maximum value as specified in 7.4.1.

When two gears are tested the arithmetic mean of the two averages for each side of these two conditions shall be calculated. The final result is the maximum value of the two calculated averages.

7.5 [Measurement uncertainty]

Measurements made in conformity with this international standard result in levels that are influenced by various conditions. Tests of a vehicle at the same site, in similar climatic conditions will result in sound pressure levels that are within ± 1 dB (A). Tests conducted on the same vehicle under different climatic conditions can result in sound pressure level variations of ± 2 dB (A). Tests conducted on different sites can result in sound pressure variations of ± 3 dB (A). [This section will be expanded by future work. Refer Annex A for further details about influencing factors.]]

8 Test report

The test report includes the following information:

- a) reference to this International Standard;
- b) details of the test site, site orientation and weather conditions including wind speed and air temperature. Wind direction, barometric pressure, and humidity

- c) the type of measuring equipment including the windscreen;
- d) the A-weighted sound pressure level typical of the background noise; optional
- e) the identification of the vehicle, its engine, its transmission system, including available transmission ratios, size and type of tyres, tyre pressure, tyre tread depth, tyre production type, power, test mass, power to mass ratio, vehicle length and location of the reference point;
- f) the transmission gears or gear ratios used during the test;
- g) the vehicle speed and engine speed at the beginning of the period of acceleration, and the location of the beginning of the acceleration;
- h) the vehicle speed and engine speed at PP' and at end of the acceleration;
- i) method used for calculation of the acceleration;
- j) the auxiliary equipment of the vehicle, where appropriate, and its operating conditions;
- k) all valid A-weighted sound pressure level values measured for each test, listed according to the side of the vehicle and the direction of the vehicle movement on the test site.

[An example for a test report will be added to the Annex.]

Annex A (normative)

Measurement uncertainty

This International Standard has been modified, in relation to ISO 362:1994, to improve the repeatability and reproducibility of the measurements. The procedure still does not require a higher level of precision for some test parameters, because there is insufficient data to justify tighter tolerance or limits on these requirements.

The use of the asphalt surfacing specified in ISO 10844 has reduced the variation typical in earlier measurements. However, ISO and Society of Automotive Engineers (SAE) test programs (see Annex B) have indicated that there is still some variation in sound pressure level measurements of identical vehicles on surfaces meeting the site qualifications. In addition to the site variation, there are vehicle and measurement variations attributable to climatic conditions. A reduction of the temperature range to 10 °C to 30 °C generally produces better agreement in the results (see annex B, ref. [4]). Likewise it should be noted that temperature, humidity and atmospheric pressure could have a significant influence on engine performance and microphone response. There is also a level of uncertainty introduced by the wind disturbance of the propagation path.

More precise calibration, better instrument specifications, and test operation criteria in this revised edition reduce the variations in sound pressure levels. Also, the variations that will occur may be easier to explain since this International Standard now requires or recommends important meteorological parameters be recorded. However, there remain variations that cannot be accounted for within the allowed ranges. Tests from one site to another and during different, but accepted, climatic conditions will normally vary around ± 1 dB, but in extreme cases variations of ± 2 dB may occur. Test data of identical products should be evaluated taking into account these factors if the measurements are found to be out of the range that would be anticipated from previous measurements.

Surface temperature. Tyres, Background noise.

[Some regulatory organisations specify a reduction of the measured level, by 1 dB, to account for this type of variation. However, such modification of measured levels are out of the scope of the ISO engineering standards. The variations also support the idea of rounding the measured level to the nearest integer in cases where the test parameters are not closely controlled. Engineering comparisons where meteorological and other parameters are restricted or controlled, will reduce this variation to where reporting levels to the nearest 0,1 dB may be significant. **]**

[to be updated before DIS]

Annex B (informative)

Technical background information

Introduction

Historically, there has been recognition within the community and the motorcycle industry that existing noise test procedures for motorcycles are deficient, in so far as the basis for these procedures was not derived from motorcycle specific data. Additionally, there has been recognition that the majority of real in-use motorcycle usage in urban environments, in terms of frequency, is partial throttle operation and not wide-open throttle operation. Therefore, conceptually, ISO/TC22/SC22/WG16 developed this procedure in a manner that would approximate partial throttle operation through the mathematical interpolation of a wide-open throttle and steady state, constant speed test. While capturing partial throttle noise is therefore essential, interpolation is necessary since throttle control at specific partial throttle openings presents serious control problems in any procedure in terms of consistency and equality across various motorcycle brands and models.

In 1994, the International Motorcycle Manufacturers Association (IMMA) collected in-use data for vehicles of category L3 (two-wheeled motorcycles) to study motorcycle behaviour in everyday urban traffic situations.

Additional in-use data was collected in 1999 and 2000 through the tripartite WMTC (Worldwide Motorcycle Test Cycle) project in which the Dutch Ministry of the Environment (VROM), the Dutch research institute TNO-Automotive and IMMA took part. Though the aim of this WMTC project was to collect data with which to construct a motorcycle-specific exhaust emissions test cycle for motorcycles, ISO/TC22/SC22/WG16 considered the data equally suitable for the definition of a new noise test procedure, which should be more representative than those, used to date.

In 2002 and 2003, ISO/TC22/SC22/WG16 collected additional in-use data for low-performance motorcycles to enhance the coverage of the database.

ISO/TC22/SC22/WG16 agreed to retain the existing measurement procedure for categories L4 and L5 as contained in ISO 362:1998 until data for these categories becomes available in the future. Categories L1 and L2 (two- and three-wheeled mopeds) are excluded from this standard and are covered by ISO 9645.

In-use driving behaviour data

The in-use driving behaviour data used for the WMTC project consist of the following subsets:

- Data measured in Europe
 - 1994 (Paris, F and Pisa, I)
 - 1994 (Amsterdam, NL and Frankfurt, D)
 - 1999 (Pisa, I; Mandeure, F and Munich, D)
 - Technische Fachhochschule Biel in Switzerland (Biel, CH)

- Technical University of Darmstadt (Darmstadt, D)
- Data measured in Japan
 - 1992 (Tokyo, J)
 - 1997 (Tokyo, J)
 - 2000 (Tokyo, J (including highway))
 - 2002/3 (Tsuchiura and Tsukuba, J)
 - 2004 (Pisa, I)
- Data measured in China
 - (Ji Nan, China)
- Data measured in the USA
 - 1999 (Birmingham (AL), USA)

WMTC Reference Database

For developing the new noise test procedure (which should be as effective as possible in limiting the noise exposure of citizens), the WMTC database was reduced to in-use data representative for urban and suburban areas. This data covers vehicle speeds ranges that are most closely associated with typical motorcycle usage in residential areas.

A frequency distribution of part 1 data is given in Figure 7:

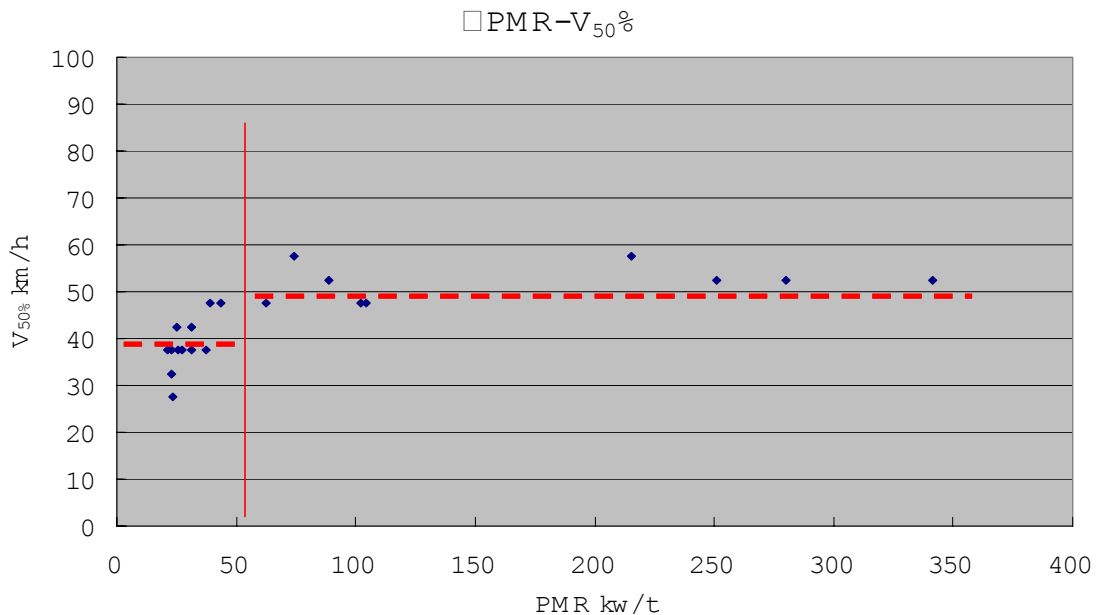


Figure 7: Vehicle speed frequency distribution of WMTC

As can be derived from Figure 7, the most frequently used speed range is that between 35 and 45 km/h below 50 kW/t and between 45 and 55 km/h above 50 kW/t, which therefore leads to test speeds of 40 respectively 50 km/h at the centerline of the test zone. This also provides a basis around which accelerations need to be examined in the relevant data to determine target accelerations for the accelerative portion of the procedure.

Target acceleration curves

The flowchart below (Figure 8) outlines the procedure according to which both the 95th percentile of the urban acceleration and normalised engine speed are determined as a function of P/m. P/m was taken as most appropriate indicator of acceleration capability. Therefore vehicles are characterised by P/m for the procedure.

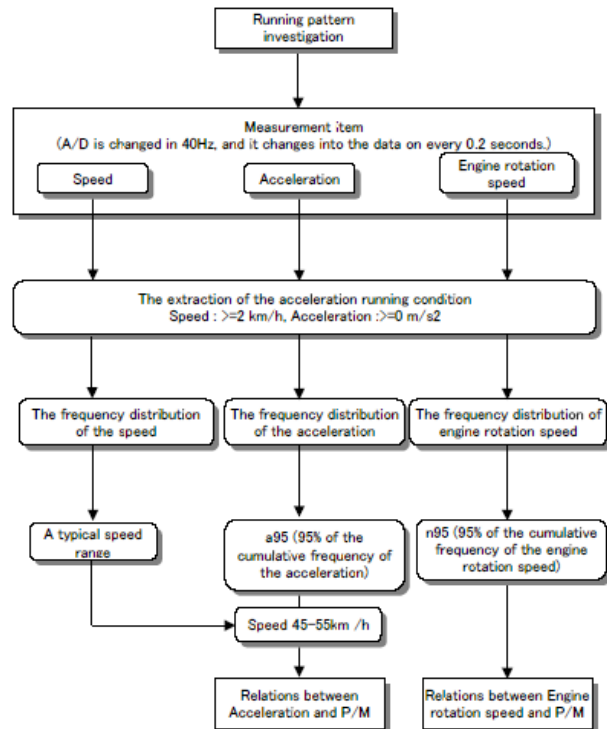


Figure 8: Target acceleration curve flow chart

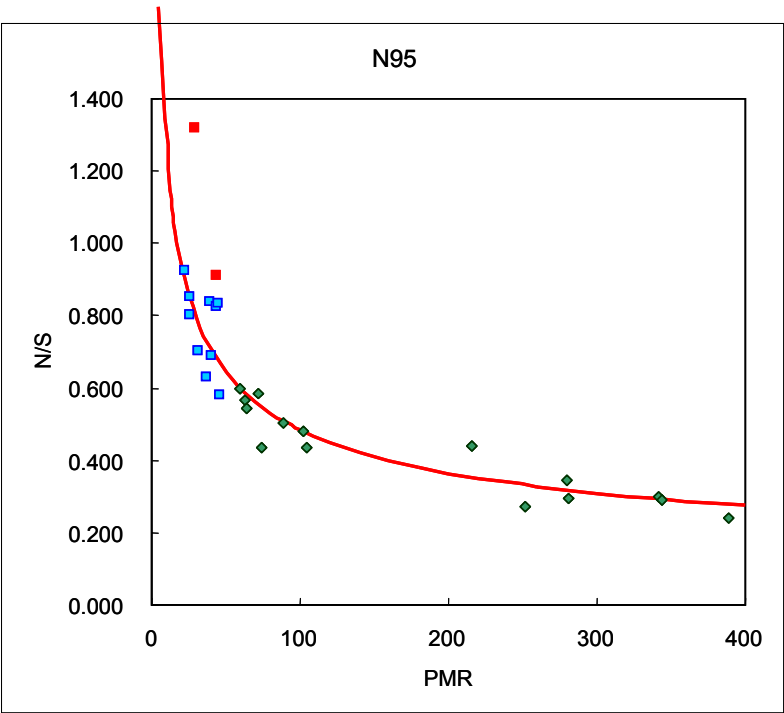


Figure 9: n_{95} as function of PMR

Method of determining a WOT acceleration line

ex :

Power to mass ratio 43.4 (kW/t)
Engine speed at PS max. 9000 (rpm)

Gear	(N/S) 95 95percentile value of accumulated frequency of engine speed	Vehicle speed at (N/S) 95 (km/h)	To select two gear positions which vehicle speed at (N/S) 95
1st	0.696	32.6	
2nd	0.696	49.6	
3rd	0.696	65.1	
4th	0.696	79.1	
5th	0.696	92.4	

- Each gear vehicle speed that it is equivalent to the n/s_{95} value of ENG speed is calculated.
- To select the gears which are each calculated vehicle speed over and under 50k/h
- WOT acceleration test is done with each gear, and vehicle speed (acceleration) is measured (Approach speed 50K/H)
Calculate(Measre) : $\alpha(i), \alpha(i+1)$
- Calculate method
 $K = (\alpha(i) - \alpha(i+1)) / (V(n/s_{95}(i+1)) - V(n/s_{95}(i)))$
 $WOT \alpha(50k/h) = \alpha(i) - K * ((50 - V(n/s_{95}(i))) / (V(n/s_{95}(i+1)) - V(n/s_{95}(i))))$
- Calculate regression curve WOT

The above table (still to be revised) outlines the procedure used to derive the WOT acceleration curve.

It needs to be noted that the typical in-use accelerations are lower than actual WOT accelerations in the noise test. Initially, the idea was to use a gear that yielded a WOT acceleration matching the in-use data for a certain PMR. The problem with this approach was however that these gears would have to be run at too low engine speeds that would not have been representative and simply undrivable.

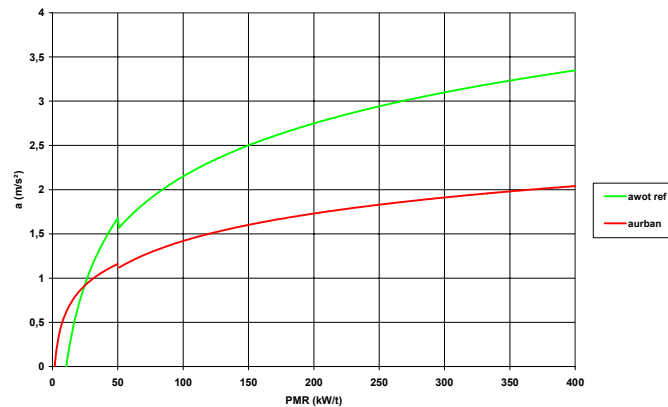


Figure 10: a_{urban} and $a_{wot\ ref}$ as function of PMR

Note: Above charts/figures to be revised for easier readability and uniform format.

It remains to be emphasized that due to motorcycle-specific in-use behaviour, there are certain differences between the final procedures developed for motorcycles and passenger cars. These differences are due to higher PMR and lower accelerations in urban use compared with the acceleration potential.

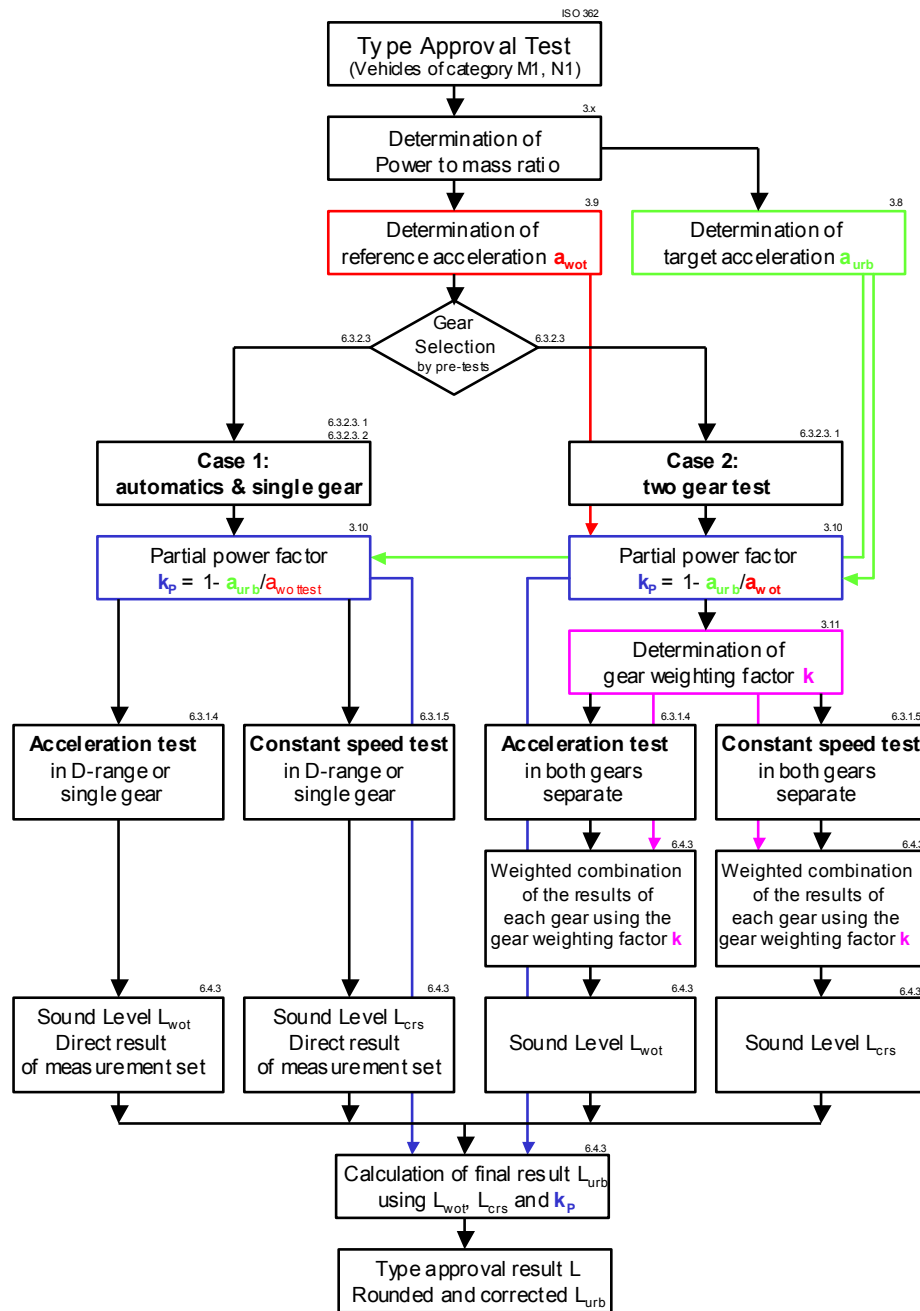
Still to be added:

- wording to explain 1-gear simplification (including assessment of noise level variability; to explain the 10% acceleration tolerance we are instituting for the 1 vs. 2 gear scenario in terms of the issues that arise from 5% and also the noise level variability found)
- extensive verification testing by WG16 members to validate, verify, and fine tune the procedure. The annex needs to mention all the manufacturer testing that supported the development through its various phases
- test data spreadsheet which could be included as an attachment, or a separate annex

Annex C

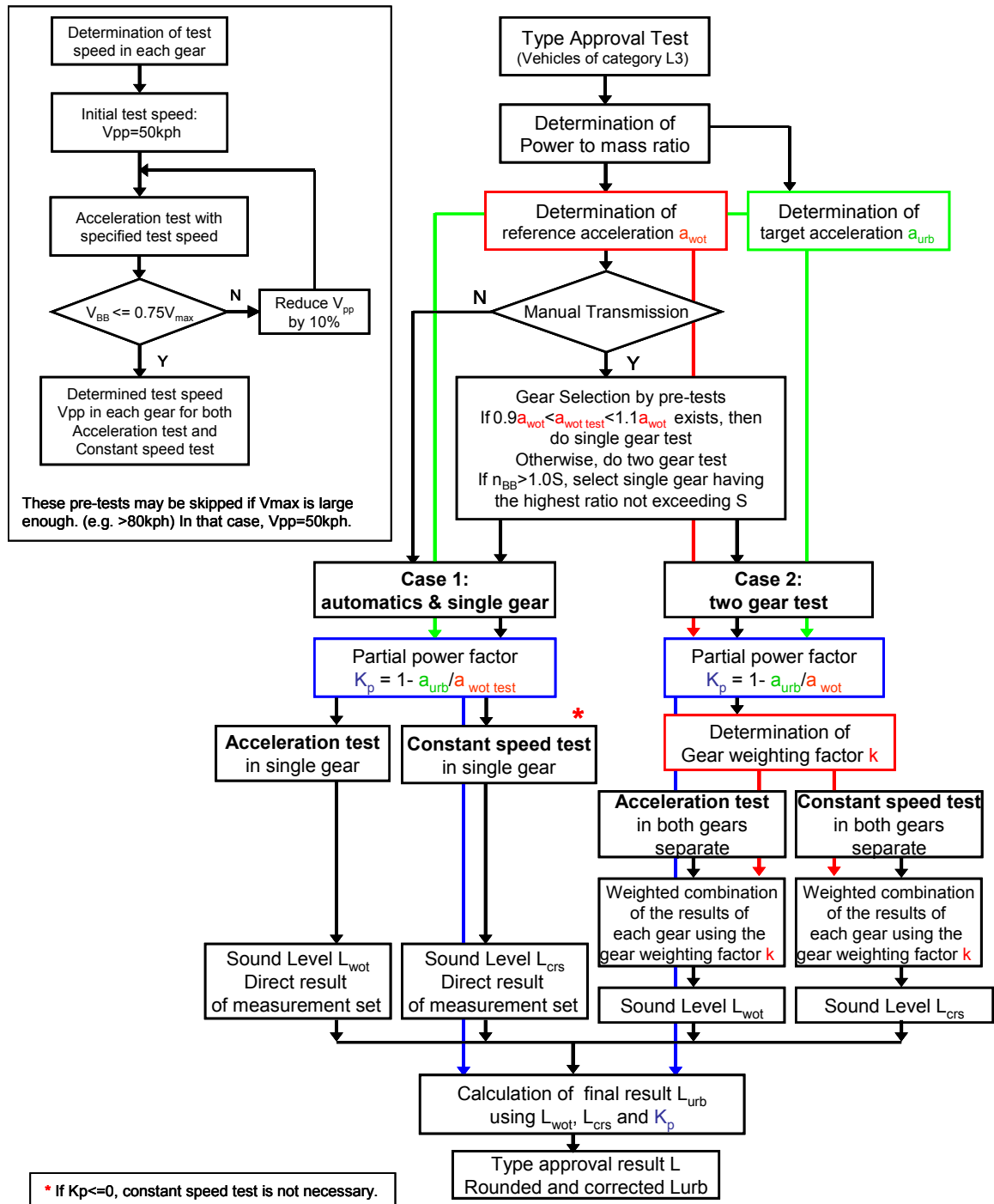
(informative)

Flow chart of the procedure for vehicles of category M1, N1, and M2 having a maximum authorized mass not exceeding 3500kg.



Annex D (informative)

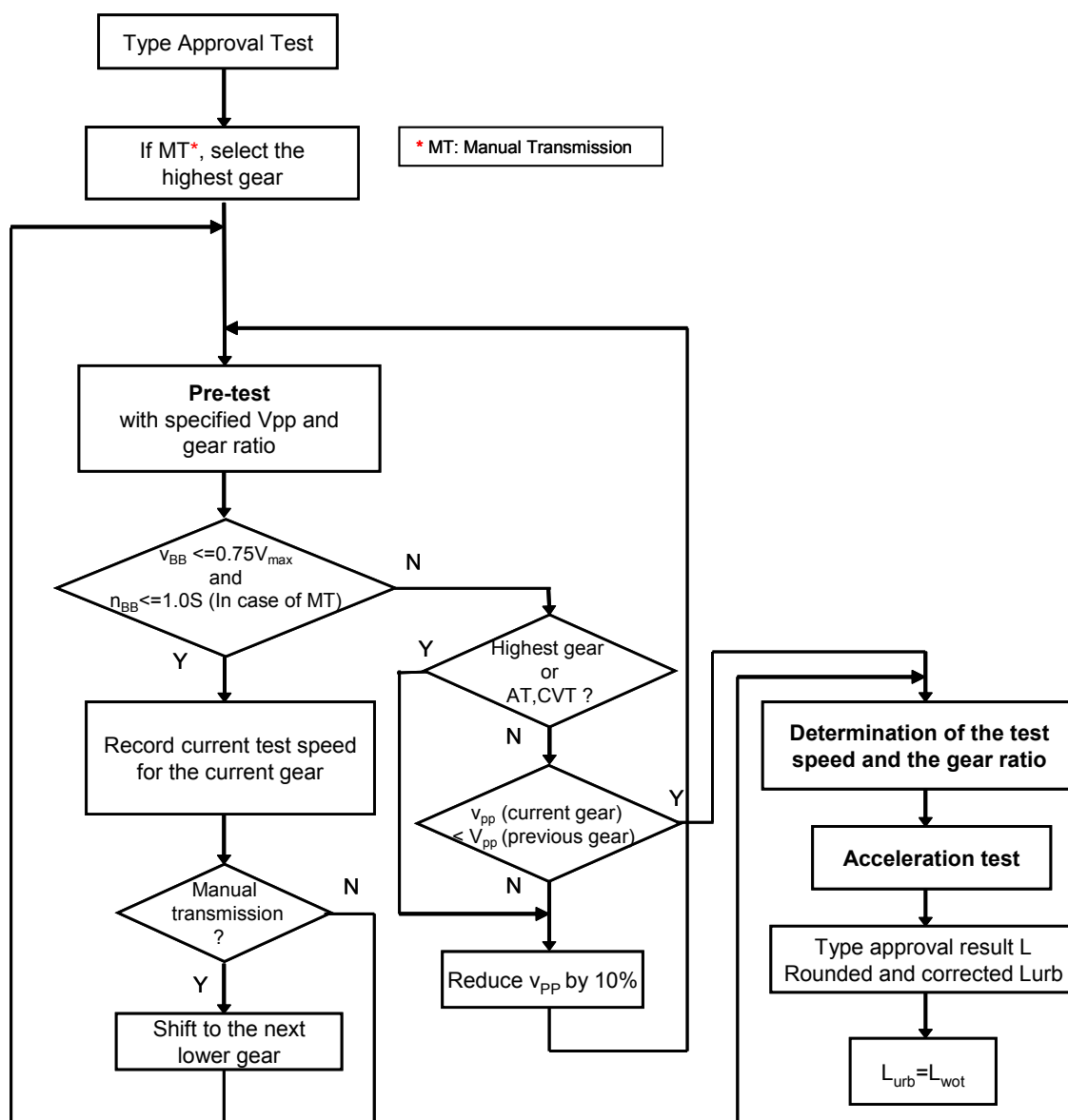
Flow chart of the procedure for category L3 (25<PMR)



Annex E

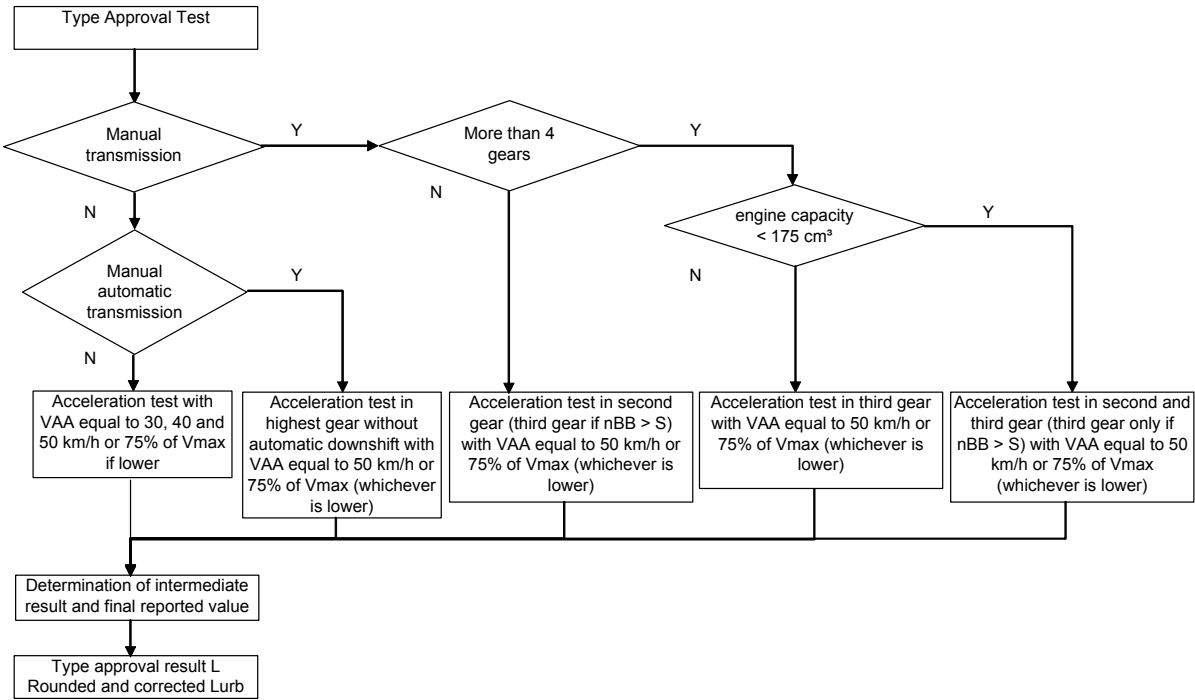
(informative)

Flow chart of the procedure for category L3 (PMR 25)



Annex F
(informative)

Flow chart of the procedure for vehicles of category L4 and L5



Annex G

(informative)

Indoor test operation

Indoor Test Operation

With the technological advancements in room acoustics, vehicle dynamometer simulation and digital signal processing typically available in today's market place, it is possible to conduct vehicle exterior noise measurements indoors with a high degree of accuracy. Testing conducted at various indoor facilities has shown good correlation to similar tests performed at conventional open-air test site. Conducting testing, as described in this standard, in an indoor environment eliminates constraints due to ambient conditions such as weather and background noise. In addition, indoor testing can provide significant timesavings during vehicle development programs in which many iterative tests are performed.

The information given in this annex outlines the basic requirements for such an indoor test facility, as well as, information to improve correlation of indoor and open-air testing.

C.1 Concept

The exterior noise test operation described in this standard is designed to measure the noise radiated from a vehicle to a stationary bystander on the street during an urban driving cycle. One of the principal criteria of the standard is that testing be performed in an acoustic free field or more precisely a hemi-anechoic space. This acoustic criteria can be reproduced in a laboratory by installing sound absorbing wedges in a sufficiently large dynamometer room to provide a hemi-anechoic space with the same effective propagation characteristics as an open-air space.

A dynamometer test bench is used to simulate the road operation of the vehicle. The vehicle's radiated noise is measured using a roving microphone or microphone array, which collects time based acoustic data. Movement of the vehicle past the stationary measurement point, as in open-air testing, is simulated using digital signal processing techniques and a synchronized sampling of the time based acoustic data.

C.2 Room Requirements

The determining factor in the room width dimension is the desired low frequency cut-off of the hemi-anechoic space. As a general rule the microphones must be $\frac{1}{4}$ wavelength from the absorptive walls and the absorptive media must be nominally $\frac{1}{4}$ wavelength of the lowest frequency of interest. As an example, if a 4 cylinder engines being tested has a lower engine speed of 1000 RPM, then the lowest firing frequency of the engine is approximately 34 Hz. To design a hemi-anechoic room with a low frequency cut-off of 34 Hz, the wedge thickness would nominally be 2.6m. For this example, the outer dimension of the test room should be approximately 18m for a single side facility, or 27m for a dual sided facility.

The length of the room depends on the length of the longest vehicle to be tested plus the length of the test track (20m), plus the space for the absorbing wedges and microphone placement. For a typical vehicle of 5m lengths, the room should be 36 m long.

The height of the room follows a similar set of requirements, however, a nominal value used is 7.5m to the wedge face (which equates to an outside dimension of 10.1m).

All room dimensions should be adjusted to meet the specific application for the products being tested.

C.3 Dynamometer Requirement

There are any numbers of dynamometer drive systems available for this use. The unit must be capable of applying a road load to the drive wheels of the vehicle, in many cases all four. The unit must also be designed to be quiet enough to be 15 dB below the lowest level being measured in the test cell. In general a dynamometer with an operating level of near 50 dB (A) will meet most requirements. In practice many facilities exhibit ambient noise levels as low as 34 dB (A). A full acoustic spectrum analysis should be made of the facility to ensure the acoustic quality of the test space.

Finally the dynamometer unit must be able to follow the rapid transient of the vehicle acceleration cycle. In many cases the operation of the vehicle is controlled using a computerized throttle application. If the vehicle is to be driven by human control extra care must be taken in the design of the facility air-handling system (see below). However, note that human variation increases the variation of the total measurement system.

C.4 Air-Handling System Requirement

To fully simulate the open-air vehicle noise test as described in this standard, the vehicle must be tested with its exhaust system fully exposed to the acoustic space. This type of testing can lead to the dangerous collection of high levels of carbon monoxide and other harmful gases. For this reason the laboratory test chamber must be sufficiently sealed to prevent leakage of these harmful gases to surrounding occupied spaces. In addition the facility must include an exhaust system able to move sufficient clean air into the test space to remove the vehicles exhaust fumes. Such a system must be designed to be quiet if run on an automatic schedule. The facility should also be instrumented with a carbon monoxide level monitoring system.

Vehicle cooling must be addressed for prolonged testing. Typically a large volume fan can be fitted in front of the vehicle to provide sufficient airflow around the vehicle. Such fans can, however, be very noisy and should only be operated in between test runs. The control of the ambient temperature within the test facility is also a consideration. Generally an ambient level of 20+/- 3°C is feasible for most applications.

C.5 Microphone Placement

Typical facilities currently in use utilize 15 to 20 microphones placed in a line on either one side or both sides of the vehicle. The microphone array is placed at a distance of 7.5 m from the longitudinal centerline of the vehicle. In most cases the array is evenly spaced along the line with the array extending from 10 meters in front of the vehicle microphone to 10 meters behind the rear of the vehicle.

C.6 Data Analysis

Acoustic data from each of the measuring microphones is acquired and stored as time histories to computer memory. At the same time, data is acquired to quantify the vehicle speed, and engine speed during the test. These various sources of information are combined based on a trigger signal relating to line AA of the test track when the accelerator throttle is applied. The time data from each of the microphones is sequenced in time, based on the speed of the vehicle and its simulated position along the test track. Through the process of combining these signals a virtual sweep is made of the microphone array to represent the movement of the vehicle past a single microphone. The digital signal processing system provides a single plot of the overall sound level of the vehicle as a function of its position along the "course". In addition, typical commercially available systems generally have the capability to provide additional time-based analysis of each of the individual microphones. This enhances the capability of defining specific noise sources, such as the level from the microphone directly in line with the exhaust outlet or at the centerline of the vehicle front axle. Most data processing systems offer an array of analysis tools that provide a detailed mapping of the vehicle noise information.

C.7 Measurement Capability

Typical facilities in use today demonstrate good correlation between open-air road tests and indoor dynamometer tests for the powertrain portion of overall vehicle noise. These facilities have become valuable tools for many vehicle manufactures.

Unfortunately correlation for the full vehicle continues to be problematic. The primary issue remaining in the correlation of indoor test facilities to open air facilities is the proper measurement of the tyre/road noise component of overall vehicle noise. For most facilities, when a production tyre is placed on an average diameter dynamometer roll its contact patch is modified such that the noise levels produced increase significantly from those produced on the flat test road surface. This situation is highly dependent on the tyre size and construction, and does not necessarily affect all vehicle types in the same fashion.

To improve test correlation, the use of tyres with no tread (blank tread tyres) can be used and have been shown to provide good results. The noise produced by the tyre/road interface must then be accounted for by other means. Research in underway by some organizations to measure vehicle tyre/road noise independently then combine the results of the two tests to determine the full vehicle noise level.

Even with the current limitation to full vehicle correlation, the ability to conduct vehicle exterior noise tests in an indoor environment has been shown to be beneficial. The indoor method eliminates restrictions due to ambient conditions especially in areas where rain, snow and wind conditions result in significant time loss. Significant time is also saved in the development of vehicle components and sub-systems where iterative testing is required. Additionally, indoor testing can be used to provide validation data to verify that a component change, other than tyres, will not alter the type approval sound level of a vehicle.

Bibliography

- [1] Enz, W and Steven, H. *Round Robin Test on test tracks as proposed in ISO/TC 43/SC 1/WG 27*. Report No. 10505993/01, FIGE GmbH, Herzogenrath, Germany, 1992.
- [2] Schumacher, R.F., Phanuef, K.G. and Haley, W.J. *SAE Noise & Vibration Conference Report*, Paper 951361 – SAE and ISO Site Variability.
- [3] ACEA, OICA, Technical Background Paper, submitted to GEB 2000
- [4] IMMA, Motorcycle Noise: The Curious Silence, 1995
- [5] Steven, H., WMTC technical report (WMTC – 2003-XXX), 2003