INTERNATIONAL STANDARD

ISO 17201-1

First edition
2005-08-01

Acoustics — Noise from shooting ranges —

Part 1: Determination of muzzle blast by measurement

Acoustique — Bruit des stands de tir —

Partie 1: Mesurage de l'énergie sonore en sortie de bouche

Reference number
ISO 17201-1:2005(E)

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Published in Switzerland

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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 which 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 17201-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 17201 consists of the following parts, under the general title *Acoustics — Noise from shooting ranges*:

— *Part 1: Determination of muzzle blast by measurement*

— *Part 2: Estimation of muzzle blast and projectile sound by calculation*

— *Part 4: Prediction of projectile sound*

The following parts are under preparation:

— *Part 3: Guidelines for sound propagation calculation*

— *Part 5: Noise management*

The initiative to prepare a standard on impulse noise from shooting ranges was taken by AFEMS, the Association of European Manufacturers of Sporting Ammunition, in April 1996, by the submission of a formal proposal to CEN. After consultation in CEN in 1998, CEN/TC 211, *Acoustics*, asked ISO/TC 43/SC 1, *Noise*, to prepare the ISO 17201 series.

Introduction

To obtain reliable data for the prediction of shooting sound levels at a reception point, the energy of sound emission produced by the muzzle blast is needed. The muzzle blast is produced by the propellant gas expelled from the barrel of a weapon; in most cases the gas has a supersonic fluid speed. Close to the muzzle, the sound pressure is very high and cannot be described with linear acoustics. For the purposes of this part of ISO 17201, the non-linear region is defined by the observation of a peak sound pressure level of 154 dB or more. This part of ISO 17201 defines how the sound source energy and directivity of the muzzle blast can be obtained from the measurement of sound exposure levels and how these measurements are to be carried out. The source energy, its directivity and spectral structure may be used as input for sound propagation models for environmental noise assessment. This cannot be used for calculations of sound exposure levels close to the weapon, for instance to estimate injury to people or animals.

Acoustics — Noise from shooting ranges —

Part 1:
Determination of muzzle blast by measurement

1 Scope

This part of ISO 17201 specifies a method to determine the acoustic source energy of the muzzle blast for calibres of less than 20 mm or explosive charges of less than 50 g TNT equivalent. It is applicable at distances where peak pressures less than 1 kPa (equivalent to a peak sound pressure level of 154 dB) are observed. The source energy, directivity of the source and their spectral structure determined by this procedure can be used as input data to sound propagation programmes, enabling prediction of shooting noise in the neighbourhood of shooting ranges. Additionally, the data can be used to compare sound emission from different types of guns or different types of ammunition used with the same gun.

This part of ISO 17201 is applicable to guns used in civil shooting ranges but it can also be applied to military guns. It is not applicable to the assessment of hearing damage or sound levels in the non-linear region.

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 9613-1, *Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere*

IEC 60942:2003, *Electroacoustics — Sound calibrators*

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Part 1: Specifications* [1)]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
instantaneous sound pressure
p
total instantaneous pressure at a point, in the presence of a sound wave, minus the atmospheric pressure at that point

NOTE The instantaneous sound pressure is expressed in pascals.

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1) Amalgamated revision of IEC 60651 and IEC 60804.

3.2
sound pressure level
L_p
ten times the logarithm to the base of 10 of the square of the ratio of a given root-mean-square sound pressure to the reference sound pressure

NOTE 1 The reference sound pressure is 20 µPa.

NOTE 2 The sound pressure level is expressed in decibels.

NOTE 3 The sound pressure level can be frequency weighted and time weighted.

3.3
peak sound pressure
p_{peak}
maximum absolute value of the instantaneous sound pressure during a stated time interval

NOTE The peak sound pressure is expressed in pascals.

3.4
peak sound pressure level
L_{peak}
ten times the logarithm to the base of 10 of the square of the ratio of the peak sound pressure to the reference sound pressure of 20 µPa

NOTE The peak sound pressure level is expressed in decibels.

3.5
event duration
T
stated time interval, long enough to encompass all significant sound of a stated event

NOTE The event duration is expressed in seconds.

3.6
sound exposure
E
time integral of frequency-weighted squared instantaneous sound pressure

$$E = \int_T p^2(t)\ \mathrm{d}t \qquad (1)$$

NOTE The sound exposure is expressed in pascal-squared seconds (Pa^2s).

3.7
sound exposure level
L_E
ten times the logarithm to the base 10 of the ratio of the sound exposure, E, to the reference sound exposure, E_0, the sound exposure being the time integral of the time-varying square of the frequency-weighted instantaneous sound pressure over a stated time interval, T, or an event

$$L_E = 10 \lg \left(\frac{E}{E_0}\right) \text{dB} \qquad (2)$$

NOTE E_0 is equal to the square of the reference sound pressure of 20 µPa multiplied by the time interval of 1 s ($400\ \mu\text{Pa}^2 \cdot 1\ \text{s}$).

3.8
source energy
Q
total sound source energy of the event

NOTE 1 The source energy is expressed in joules.

NOTE 2 The reference to 1 s yields the sound power L_W of a repeated event as defined in ISO 9613-2.

3.9
source energy level
L_Q
ten times the logarithm to the base 10 of the ratio of source energy, Q, to the reference source energy, Q_0

$$L_Q = 10 \lg \left(\frac{Q}{Q_0} \right) \text{dB} \tag{3}$$

where

$Q_0 = 10^{-12}$ J

NOTE The source energy level is expressed in decibels.

3.10
angular source energy distribution
$S_q(\alpha)$
acoustic energy radiated from the source into the far field, per unit solid angle

NOTE 1 The acoustic energy radiated by the source within a narrow cone centred on the direction α is

$$S_q(\alpha) = \frac{\mathrm{d}Q}{\mathrm{d}\Omega} \tag{4}$$

NOTE 2 Ω is the solid angle expressed in steradians.

NOTE 3 The angular source energy distribution $S_q(\alpha)$ is expressed in joules per steradian (J·sr^{-1}).

NOTE 4 Rotational symmetry is assumed around the line with $\alpha = 0$.

3.11
interpolated angular source energy distribution
$\overline{S}_q(\alpha)$
continuous function in α of the source energy distribution $S_q(\alpha)$, derived by using a defined interpolation method

NOTE The interpolated angular source energy distribution, $\overline{S}_q(\alpha)$, is expressed in joules per steradian (J·sr^{-1}).

3.12
angular source energy distribution level
$L_q(\alpha)$
angular source energy distribution as a level relative to 10^{-12} J

$$L_q(\alpha) = 10 \lg \left(\frac{S_q(\alpha)}{S_{q0}(\alpha)} \right) \text{dB} \tag{5}$$

where

$S_{q0}(\alpha) = 10^{-12}$ J·sr^{-1}

NOTE The angular source energy distribution level, $L_q(\alpha)$, is expressed in decibels.

3.13
interpolated angular source energy distribution level
$\underline{L}_q(\alpha)$
continuous function in α of the angular source energy distribution level, $L_q(\alpha)$, derived by using a defined interpolation method

NOTE The interpolated angular source energy distribution level is expressed in decibels.

3.14
angle alpha
α
angle between the line of fire and a line from the muzzle to the receiver (see Figure 3)

NOTE The angle alpha is expressed in radians in all formulae.

3.15
angle beta
β
angle describing the rotation around the line of fire, anticlockwise from the view of the shooter, as the angle between the horizontal plane intersecting the muzzle from the right-hand side (see Figure 3)

NOTE The angle beta is expressed in radians in all formulae.

3.16
angle gamma
γ
angle describing the inclination of the line of fire from the horizontal plane (see Figure 3)

NOTE The angle gamma is expressed in radians in all formulae.

3.17
angle delta
δ
angle constituted by the projection of angle α on the horizontal plane (see Figure 3)

NOTE The angle delta is expressed in radians in all formulae.

3.18
directivity
$D(\alpha)$
difference between the angular source energy distribution level of the source under test and the source energy distribution level of a monopole source with the same acoustic source energy

NOTE The directivity is expressed in decibels.

3.19
muzzle distance
r_{m}
distance measured from the muzzle to the microphone point (see Figure 3)

NOTE The distance is expressed in metres.

4 Gun and ammunition

4.1 General

The information given in 4.2 to 4.6 is needed to unambiguously define the weapon plus ammunition combination for which the sound exposure level of the muzzle blast is estimated (items marked by an asterisk are mandatory). All terms have the meanings given in Reference [1] and Annex A.

4.2 Gun

The following features shall be stated:

— *description or brand name;

— *type of gun (shot gun, rifle, revolver, pistol, etc.);

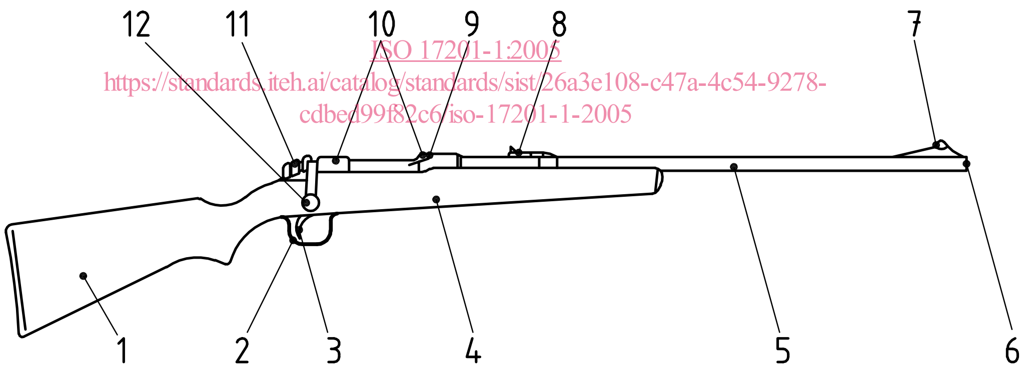
— number, type and disposition of barrels (side-to-side, superposed, drilling, etc.);

— calibre;

— *barrel bore;

— *barrel length.

Figure 1 is a schematic view and gives the main terms used to describe the gun.



Key

1	stock	7	front sight
2	trigger guard	8	rear sight
3	trigger	9	bolt
4	magazine (inside)	10	receiver
5	barrel	11	safety lock
6	muzzle	12	bolt handle

Figure 1 — Main terms used to describe the gun (schematic view)

The main parts of smooth-bore barrel and a rifled barrel are given in Annex A.

Special features such as

— choke,

- reload system,
- *flame shield, and
- *muzzle brake

should be mentioned.

4.3 Ammunition

The following information is needed:

- *description or brand name;
- *projectile calibre;
- type and mass or chemical energy of propellant;
- type of projectile (ball, pellets or blank);
- *projectile mass.

In the case of shot guns:

- total length of the cartridge;
- type of tube;
- type of wad;
- *type, number, size and weight or type-number of pellets;
- type of crimping.

Schematic views of bullet projectiles and shot gun cartridges are shown in Figure 2 with the names of their main components.

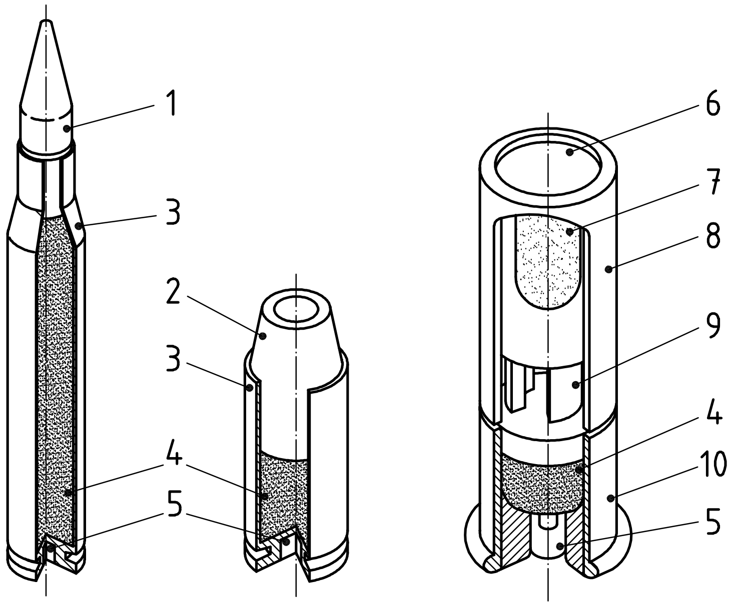
4.4 Ballistic parameters

State parameters like

- *muzzle speed (speed of the projectile close to the muzzle),

as result of a gun/ammunition combination as specified by the manufacturer.

NOTE Muzzle speed is a calculated value that corresponds to the speed of the projectile itself for rifles, or to the speed of the centre of gravity of the cloud of pellets close to the muzzle of a shot gun.



Key

1 projectile (bullet) for rifle
2 projectile (bullet) for pistol
3 case
4 powder
5 primer
6 tube
7 shot pellets
8 plastic cylinder
9 wad
10 case head

NOTE The measurements can be influenced by conditions such as the heating of the barrel during repetitive shooting, the temperature, the humidity and the age of the ammunition.

Figure 2 — Schematic view of bullet projectiles and a shot gun cartridge

4.5 Test situation

Any object that can cause reflections or shield the muzzle blast shall be mentioned. Such objects can, for example, be a part of the weapon, the support of the weapon or part of this support. Also the gunman can be seen as a part of the weapon system that can shield the muzzle blast. All these elements, which are commonly used under normal operation of the weapon, shall be present during the measurement and should be mentioned in the report. Other circumstances which may affect the noise source data should also be reported. The gun shall be positioned as it would be under normal operating conditions. If the gun is put on a high support and fired with a rope, the shielding effect of the gunman is not taken into account. Therefore it should be ensured that the experimental set up is as close to normal operation conditions as possible (see also 7.2).

4.6 Other features

All other information concerning the test conditions or anything that may affect measured source data shall be reported.

EXAMPLES

— the barrel in use in the case of a combination firearm, if the barrels have different features, especially bore,

— special features, like silencers, muzzle brakes, etc., and

— storage conditions of the ammunition (temperature, humidity, duration, etc.).