INTERNATIONAL STANDARD **ISO 3930**

INTERNATIONAL RECOMMENDATION **OIML R 99**

Third edition
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Instruments for measuring vehicle exhaust emissions

Instruments de mesure des gaz d'échappement des véhicules

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3930 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 5, *Engines tests*.

This third edition cancels and replaces the second edition (ISO 3930:1993), which has been technically revised.

Annexes A, B and F form an integral part of this International Standard/Recommendation. Annexes C, D and E are for information only.

NOTE Since this ISO International Standard is also an OIML International Recommendation, the designation “International Standard/Recommendation” is used throughout the text.

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

— International Recommendations (OIML R), which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;

— International Documents (OIML D), which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by technical committees or subcommittees which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and International Documents are published in French (F) and English (E) and are subject to periodic revision.

This publication — reference OIML R 99, edition 2000 (E) — was developed by the OIML subcommittee TC 16/SC 1, *Air Pollution*. It was approved for final publication by the International Committee of Legal Metrology in 1997, and will be submitted to the International Conference of Legal Metrology in 2000 for formal sanction; it supersedes the previous edition dated 1991.

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NOTE Since this OIML International Recommendation is also an ISO International Standard, the designation "International Standard/Recommendation" is used throughout the text.

Instruments for measuring vehicle exhaust emissions

1 Scope

This International Standard/Recommendation specifies the metrological and technical requirements and tests for measuring instruments [hereafter termed "instrument(s)"] that serve to determine the volume fractions of certain components of the exhaust gases emanating from motor vehicles, and establishes the conditions with which such instruments must comply in order to meet any OIML performance requirements.

It is applicable to instruments, particularly those used according to the procedure defined in ISO 3929, intended for the inspection and maintenance of in-use motor vehicles with spark ignition engines. These instruments are used to determine the volume fraction of one or more of the following exhaust gas components:

— carbon monoxide (CO);

— carbon dioxide (CO_2);

— hydrocarbons (HC, in terms of *n*-hexane); and

— oxygen (O_2)

at the moisture level of the sample as analysed.

This International Standard/Recommendation covers instruments whose principle of detection is based on infrared absorption in gases for CO, CO_2 and HC. Oxygen is generally measured with a fuel cell. It is not intended, however, to exclude any other types of instruments that, although based on other principles of detection, meet the specified metrological and technical requirements and satisfy the associated tests. Three accuracy classes of the instruments, Class 0, Class I and Class II, are covered.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard/Recommendation. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard/Recommendation are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3929:1995, *Road vehicles — Measurement methods for exhaust gas emissions during inspection or maintenance.*

ISO 6145 (all parts), *Gas analysis — Preparation of calibration gas mixtures — Dynamic volumetric methods.*

ISO 7395, *Gas analysis — Preparation of calibration gas mixtures — Mass dynamic method.*

IEC 60068-2-1:1990, *Environmental testing — Part 2: Tests — Test A: Cold.*

IEC 60068-2-2:1974, *Environmental testing — Part 2: Tests — Test B: Dry heat.*

IEC 60068-2-3:1969, *Environmental testing — Part 2: Tests — Test Ca: Damp heat, steady state.*

IEC 60068-2-28:1990, *Environmental testing — Part 2: Tests — Guidance for damp heat tests.*

IEC 60068-2-31:1969, *Environmental testing — Part 2: Tests — Test Ec: Drop and topple, primarily for equipment type specimens, and its Amendment 1: 1982.*

IEC 60068-2-34:1973, *Environmental testing — Part 2: Tests — Test Fd: Random vibration wide band — General requirements.*

IEC 60068-2-36:1973, *Environmental testing — Part 2: Tests — Test Fdb: Random vibration wide band — Reproducibility medium, and its Amendment 1: 1983.*

IEC 60068-3-1:1974, *Environmental testing — Part 3: Background information — Section 1: Cold and dry heat tests.*

IEC 60068-3-1A:1978, *Environmental testing — Part 3: Background information — First supplement.*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test.*

IEC 61000-4-3: Ed. 1.1, 1998, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test.*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test.*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 6: Immunity to conducted disturbances, induced by radio-frequency fields.*

BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML:

International Vocabulary of Basic and General Terms in Metrology (VIM), Second edition, 1993.

3 Terms and definitions

For the purposes of this International Standard/Recommendation, the following terms and definitions apply.

3.1
sampling probe
tube that is introduced into the exhaust tail pipe of a vehicle to take gas samples

3.2
water separator
device that removes water to a level that prevents condensation within the gas handling system downstream from its location

3.3
filter unit
device that removes particulate matter from the exhaust gas sample

3.4
gas handling system
all instrument components, from the sampling probe to the gas sample outlet, through which the exhaust gas sample is conveyed by the pump

3.5
adjustment (of a measuring instrument)
operation of bringing a measuring instrument into a state of performance suitable for its use (VIM: 1993, 4.30)

3.6
user adjustment (of a measuring instrument)
adjustment employing only the means at the disposal of the user (VIM: 1993, 4.31)

3.7
manual adjustment facility
facility allowing the adjustment of the instrument by the user

3.8
semi-automatic adjustment facility
facility allowing the user to initiate an adjustment of the instrument without having the possibility of influencing its magnitude, whether the adjustment is automatically required or not

NOTE For those instruments that require the values of the volume fractions of the calibration gas to be entered manually, the facility is considered to be semi-automatic.

3.9
automatic adjustment facility
facility performing the adjustment of the instrument as programmed without the intervention of the user, to initiate the adjustment or its magnitude

3.10
zero-setting facility
facility to set the indication of the instrument to zero

3.11
calibration gas adjustment facility
facility to adjust the instrument to the value of a calibration gas

3.12
internal adjustment facility
facility to adjust the instrument to a designated value without the use of an external calibration gas

3.13
warm-up time
elapsed time between the instant power is applied to an instrument and the instant at which the instrument is capable of complying with the metrological requirements

3.14
response time
time interval between the instant when the instrument is subjected to a specified abrupt change in gas mixture composition and the instant when the response reaches within specified limits its final steady value

NOTE Adapted from VIM: 1993, 5.17.

3.15
error (of indication)
indication of a measuring instrument minus a true value of the corresponding input quantity. (VIM: 1993, 5.20)

3.16
intrinsic error
error of a measuring instrument, determined under reference conditions (VIM: 1993, 5.24)

3.17
absolute error of measurement
result of a measurement minus the conventional true value of the measurand

NOTE Adapted from VIM: 1993, 3.10.

3.18
relative error
absolute error of measurement divided by the conventional true value of the measurand

NOTE Adapted from VIM: 1993, 3.12.

3.19
fault
difference between the error of indication and the intrinsic error of the instrument

3.20
significant fault
fault the magnitude of which is greater than the magnitude of the maximum permissible error on initial verification

NOTE The following faults are considered not to be significant.

a) fault arising from simultaneous and mutually independent causes in the instrument itself or in its checking facilities;

b) faults implying the impossibility to perform any measurement;

c) transitory faults being momentary variations in the indication, which cannot be interpreted, recorded or transmitted as a measurement result; and

d) faults giving rise to variations in the measurement results that are so large as to be noticed by all users of the instruments.

3.21
influence quantity
quantity that is not the measurand but which affects the result of the measurement (VIM: 1993, 2.7)

3.22
rated operating conditions
conditions of use giving the ranges of the influence quantities for which the metrological characteristics of an instrument are intended to lie within the specified maximum permissible errors

NOTE Adapted from VIM: 1993, 5.5.

3.23
influence factor
influence quantity having a value within the rated operating conditions of the instrument

3.24
disturbance
influence quantity having a value within the limits specified in this International Standard/Recommendation but outside the rated operating conditions of the instrument

3.25
reference conditions
conditions of use prescribed for testing the performance of a measuring instrument or for intercomparison of results of measurements (VIM: 1993, 5.7)

3.26
checking facility
facility that is incorporated in the instrument and that enables significant faults to be detected and acted upon

NOTE "Acted upon" means any adequate response by the instrument (luminous or acoustic signal, blocking of process, etc.)

3.27
automatic checking facility
checking facility operating without the intervention of the user

3.27.1
permanent automatic checking facility (type P)
automatic checking facility operating during each measurement cycle

3.27.2
intermittent automatic checking facility (type I)
automatic checking facility operating at certain time intervals or per fixed number of measurement cycles

3.28
test
series of operations intended to verify the compliance of the equipment under test (EUT) with specified requirements

3.29
lambda
dimensionless value representative of the burning efficiency of an engine in terms of the air/fuel ratio in the exhaust gases and determined with a referenced standardised formula

3.30
calibration gas
stable gas mixture of known concentration used for periodic calibration of the instruments and for various performance tests

3.31
modulus (of a number) absolute value
value of the number without regard to its sign

3.32
hand-held instrument
type of instrument that is designed for hand-held transportation by one person with its standard accessories, and that rests on a suitable surface during use

4 Description of the instruments

4.1 Generally, the instruments provide a means for sampling and then measuring the exhaust gases emitted from the tail pipe of a motor vehicle. A pump provides the means for conveying the gas sample through a gas handling system. One or more detection devices, incorporated in the gas handling system, analyse the sample and provide signals related to the volume fractions of gas components of interest, namely CO, CO_2, HC and O_2. The detector signals are then electrically processed to display and possibly record the results of a measurement in volume fractions of the gas components together with other important related information such as a lambda value calculation.

4.2 Acceptable overall performance of the instrument is dependent upon its various components for the associated characteristics. An example of an instrument using gas calibration for adjustment is shown in Figure 1.

4.3 The major instrument components are as follows:

— a sampling probe introduced in the tail pipe of an operating motor vehicle to collect the exhaust gas sample;

— a hose with associated tubing connected to the probe to provide a path for the gas sample to enter, pass through and exit the instrument;

— a pump to convey the gases through the instrument;

— a water separator to prevent water condensation from forming in the instrument;

— a filter to remove particulate matter that could cause contamination of various sensitive parts of the instrument;

— ports downstream from the water separator and filter to introduce ambient air and calibration gas when required by the technology used;

— detection devices to analyse the gas sample into its components according to volume fractions;

— a data system to process the signal and an indicating device to display the results of a measurement; and

— a control facility to initiate and check instrument operations and a manual, semi-automatic, or automatic adjustment facility to set instrument operating parameters within prescribed limits.

5 Metrological requirements

5.1 Indication of the measured result

The volume fractions of the gas components shall be expressed as a percentage (% vol) for CO, CO_2 and O_2 and in parts per million (ppm vol) for HC. The inscriptions for these units shall be assigned unambiguously to the indication, for example “% vol CO”, “% vol CO_2”, “% vol O_2” and “ppm vol HC”.

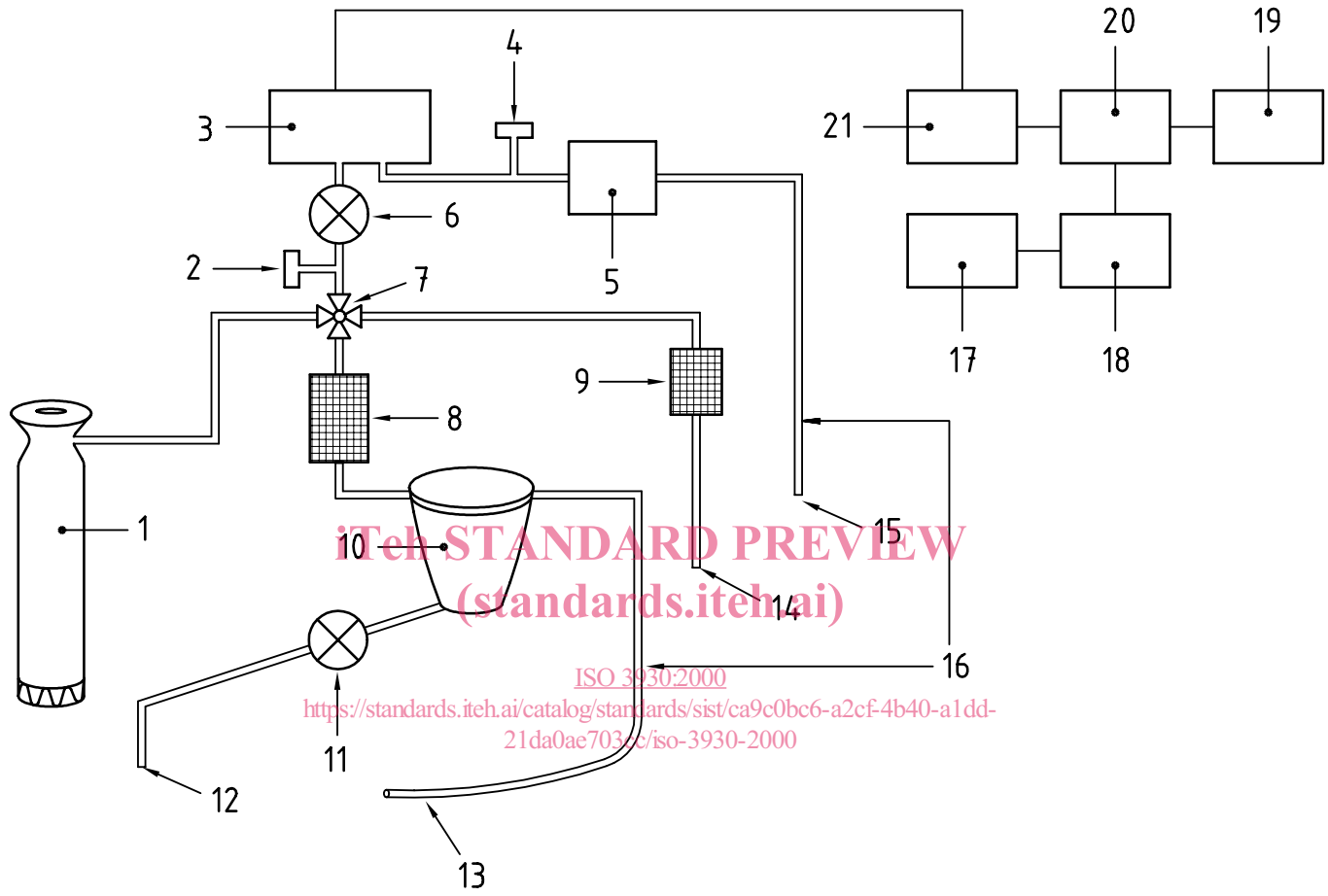
NOTE Historically, the units of volume fraction have been used for field inspection; however blended gases can generally be manufactured in molar fractions to more accurate standards. Assuming the gas mixtures obey the ideal gas law, molar fractions are considered to be equal to volume fractions in this International Standard/Recommendation.

5.2 Measuring range

The minimum indicating ranges that may be subdivided shall be as given in Table 1.

Table 1

Class	Measuring ranges			
	CO % vol	CO_2 % vol	O_2 % vol	HC ppm vol
0 and I	0 to 5	0 to 16	0 to 21	0 to 2 000
II	0 to 7	0 to 16	0 to 21	0 to 2 000



Key

1	Calibration gas input (6.1.5)	8	Filter gas (6.1.3)	15	Gas output
2	Differential pressure sensor (6.1.7)	9	Charcoal filter (6.1.5)	16	Gas handling system (6.1.8)
3	CO, CO_2 and HC analysis	10	Water separator (6.1.4)	17	Seals (6.3.8)
4	Atmospheric pressure sensor	11	Water pump	18	Adjustment facilities (6.2)
5	O_2 analysis	12	Water output	19	Interfaces (6.1.9)
6	Gas pump (6.1.6)	13	Sampling probe (6.1.2)	20	Indicating device (6.2 and 6.3)
7	Electrovalve	14	Gas input for zero-setting (6.1.5)	21	Signal conversion

Figure 1 — Diagrammatic illustration of an instrument for measuring vehicle exhaust emissions (references in parenthesis are to the relevant subclauses in the text)

5.3 Resolution of indication

5.3.1 Analog scale intervals and scale marks

The scale intervals for an analog instrument shall be 0,1 % vol or 0,2 % vol for CO, CO_2 and O_2, and 10 ppm vol or 20 ppm vol for HC. The minimum scale spacing shall be 1,25 mm. The thickness of the needle shall not be greater than one quarter of the scale spacing. The needle shall overlap at least one third of the shortest mark and shall be clearly visible. The graduation shall be designated with figures at least 5 mm high and designed in such a way as to prevent misinterpretation.

5.3.2 Digital indication

Digital figures shall be at least 5 mm high. The least significant figure of the display shall provide a resolution equal to or one order of magnitude higher than the values given in Table 2.

Table 2

Class	Minimum resolutions			
	CO % vol	CO_2 % vol	O_2 % vol	HC ppm vol
0 and I	0,01	0,1	[a]	1
II	0,05	0,1	0,1	5

[a] 0,02 % vol for measurand values ≤ 4 % vol
0,1 % vol for measurand values > 4 % vol

5.4 Maximum permissible errors

5.4.1 Maximum permissible intrinsic errors

The maximum permissible errors given in Table 3 shall apply for an instrument under the reference conditions specified in 5.5.1.

Table 3

Class	Type of indication error	Maximum permissible errors [a]			
		CO	CO_2	O_2	HC
0	Absolute	± 0,03 % vol	± 0,4 % vol	± 0,1 % vol	± 10 ppm vol
	relative	± 3 %	± 4 %	± 3 %	± 5 %
I	Absolute	± 0,06 % vol	± 0,4 % vol	± 0,1 % vol	± 12ppm vol
	relative	± 3 %	± 4 %	± 3 %	± 5 %
II	Absolute	± 0,15 % vol	± 0,5 % vol	± 0,2 % vol	± 20 ppm vol
	relative	± 5 %	± 5 %	± 5 %	± 5 %

[a] Absolute or relative, whichever is greater.

5.4.2 Maximum permissible errors on initial verification

The maximum permissible errors given in Table 4 shall apply for instruments at initial verification under the rated operating conditions specified in 5.5.2.

Table 4

Class	Type of indication error	Maximum permissible errors [a]			
		CO	CO_2	O_2	HC
0	Absolute	± 0,03 % vol	± 0,5 % vol	± 0,1 % vol	± 10 ppm vol
	relative	± 5 %	± 5 %	± 5 %	± 5 %
I	Absolute	± 0,06 % vol	± 0,5 % vol	± 0,1 % vol	± 12 ppm vol
	relative	± 5 %	± 5 %	± 5 %	± 5 %
II	Absolute	± 0,2 % vol	± 1 % vol	± 0,2 % vol	± 30 ppm vol
	relative	± 10 %	± 10 %	± 10 %	± 10 %

[a] Absolute or relative, whichever is greater.

5.4.3 Maximum permissible errors on subsequent verification

The maximum permissible errors on subsequent verification shall be provided and may be equal to or greater than the errors on initial verification.

5.5 Influence quantities

5.5.1 Reference conditions

a) temperature: 20 °C ± 2 °C;

b) relative humidity: 60 % ± 10 %;

c) atmospheric pressure: stable ambient;

d) mains voltage: nominal voltage ± 2 %, nominal frequency ± 1 %;

e) presence of influencing gas components: none except the measurands in N_2.

NOTE In case of infrared technology, a relative humidity range from 30 % to 60 % is acceptable.