INTERNATIONAL STANDARD

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Road vehicles — Measurement equipment for exhaust gas emissions during inspection or maintenance — Technical specifications

Véhicules routiers — Équipement de mesure des émissions gazeuses au cours des inspections ou des contrôles d'entretien — Spécifications techniques

Reference number
ISO 3930:1993(E)

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.

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.

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

This second edition cancels and replaces the first edition (ISO 3930:1976), of which it constitutes a technical revision.

Annexes A, B and C form an integral part of this International Standard. Annex D is for information only.

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Road vehicles — Measurement equipment for exhaust gas emissions during inspection or maintenance — Technical specifications

1 Scope

This International Standard establishes technical specifications for the instrument used for direct measurement of the concentration of exhaust gas emissions, defined in clause 1 of each annex, from road vehicles with a maximum authorized total mass not exceeding 3,5 t, equipped with a controlled ignition engine excluding those which are supplied with fuel/oil mixture.

It defines instruments, referred to as analysers, for:

— checking or adjusting in service stations;

— periodic inspections in official stations;

— official control at the road-side (by police, etc.),

when used according to the procedure defined in ISO 3929. However, analysers that conform to this International Standard are not recommended for:

— laboratory and development use;

— vehicle type approval;

— vehicle production conformity;

— end of line inspection.

These technical specifications may help the users to check the necessary technical requirements of these analysers, totally or partially.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3929:—[1], *Road vehicles — Measurement methods for gaseous exhaust emissions produced during inspection or maintenance.*

IEC 801-2:1991, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements.*

IEC 801-3:1984, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 3: Radiated electromagnetic field requirements.*

IEC 801-4:1988, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 4: Electrical fast transient burst requirements.*

3 Definitions

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

NOTE 1 They are, in general, based on [1].

3.1 absolute error of measurement: Result of a measurement minus the (conventional) true value of the measurand. [VIM:1984, definition 3.10]

3.2 accuracy of measurement: Closeness of the agreement between the result of a measurement and the (conventional) true value of the measurand. [VIM:1984, definition 3.05]

1) To be published. (Revision of ISO 3929:1976)

3.3 accuracy of analyser: Ability of an analyser to give indications approaching the true value of a measurement.

3.4 adjustment: Operation intended to bring an analyser into a state of performance and freedom from bias suitable for its use.

3.5 analog analyser: Analyser in which the output or display is a continuous function of the value of the measurand.

3.6 calibration: Set of operations which establish, under specified conditions, the relationship between values indicated by an analyser and the corresponding known values of a measurand.

3.7 checking facilities: Facilities incorporated within an analyser that enable significant faults to be indicated and acted upon.

3.8 digital analyser: Analyser which provides a digitized output and/or display.

3.9 drift: Slow variation with time of a metrological characteristic of an analyser.

3.10 maximum permissible errors: Extreme values of an error permitted by specifications.

3.11 measurand: Quantity subjected to measurement. [VIM:1984, definition 2.09]

3.12 measurement: Set of operations having the object of determining the value of a quantity. [VIM:1984, definition 2.01]

3.13 scale range: For a given scale, range of scale values between the extreme scale marks. [VIM:1984, definition 4.21].

3.14 relative error: Absolute error of measurement divided by the (conventional) true value of the measurand. [VIM:1984, definition 3.11]

3.15 repeatability of measurement: Closeness of the agreement between the result of successive measurements of the same measurand carried out subject to all of the following conditions:

— the same method of measurement;

— the same observer;

— the same analyser;

— the same location;

— the same conditions of use;

— repetition over a short period of time (generally less than one hour).

NOTE 2 Repeatability may be expressed quantitatively in terms of dispersion of the results.

3.16 resolution of indicating device: Quantitative expression of the ability of an indicating device to distinguish meaningfully between closely adjacent values of the indicated quantity. [VIM:1984, definition 5.13]

3.17 response time: Time interval between the instant when a stimulus is subjected to a specified abrupt change and the instant when the response reaches and remains within specified limits of its final steady value.

3.18 scale: Ordered set of scale marks, together with any associated numbering, forming a part of an indicating device. [VIM:1984, definition 4.19]

3.19 span: Modulus of the difference between the two limits of a nominal range of an analyser.

3.20 test: Series of operations intended to verify the compliance of the equipment with prescribed technical requirements.

3.21 true value of quantity: Value which characterizes a quantity perfectly defined, in the conditions which exist when that quantity is considered.

3.22 zero of analyser: Direct indication of an analyser when the instrument is in use with zero value of the measurand, with any auxiliary power supply required to operate the instrument switched on.

3.23 warm-up time: Elapsed time between switching on the analyser and the moment the analyser complies with the metrological requirements.

3.24 hand-held analyser: Type of analyser handheld by one person with all its standard accessories and without deterioration of its characteristics, according to the prescriptions of each national regulation and which rests, during use, on a suitable surface.

3.25 portable analyser: Type of analyser, easily carried and moved, with all its standard accessories, without deterioration of its characteristics, according to the prescriptions of each national regulation.

3.26 zero gas: Pure gas (N_2) or a gas mixture (air) used to establish the zero indication of the analyser.

4 Technical specifications

4.1 Design characteristics

4.1.1 General

With consideration of the intended application field, the analyser shall be:

a) hand-held or portable;

b) simple for use by unqualified people;

c) easy to adjust;

d) designed to respond to the specific gas constituent to be measured;

e) designed for expected and specific applications;

f) capable of directly indicating unambiguous measuring results;

g) easily resettable to primary calibration, if specified after transportation and handling;

h) correlatable with the analysers used by the manufacturer to check his own production;

i) designed to prevent any action other than those required for adjustment and measurement. In the case of destruction of the protection, the measurement shall be invalidated;

j) designed and manufactured in such a way that, when exposed to

— warm-up time other than that defined in 4.1.25,

— power supply fault,

— water separator saturation,

— electronic defaults,

it is able to interrupt the measurement readings.

4.1.2 Identification

The analyser shall have a permanent and easily readable nameplate giving the following particulars:

a) manufacturer's trademark and corporate name;

b) year of manufacture;

c) pattern approval mark and model number;

d) serial number of the analyser and if necessary the measuring transducer;

e) minimum and nominal flowrate, if necessary;

f) electrical power requirements (mains voltage, frequency, absorption, etc.)

Furthermore, the propane/hexane conversion factor and the warm-up time shall be indicated on a separate plate fixed on the front panel of the analyser.

4.1.3 Operating instructions

Documentation shall be supplied by the manufacturer with the analyser in the official language of the country where the analyser is used. This documentation shall include:

a) a description of its general principle of measurement;

b) a list of its essential components with their characteristics;

c) a description of its essential components with drawings and diagrams;

d) general information on the output for a microprocessor-equipped analyser;

e) the leak test procedure;

f) operating instructions, including those concerning periodic calibration and maintenance;

g) a list of main accessories (i.e. filters, probes, etc.).

The manufacturer shall clearly explain the kind of calibration gas to be used for the hydrocarbon analyser. If a calibration gas other than hexane is used, the manufacturer shall indicate the conversion factor.

WARNING — If hexane is used, variation of potential pressure and temperature conditions can cause it to condense within the cylinder, with subsequent loss of traceability of the calibration gas.

4.1.4 Calibration adjustment

The analyser shall have the capability of being calibrated using the calibration gas bottle method and possibly electro-mechanical or electronic methods.

4.1.5 Adjustment facilities

The analyser shall be equipped with a zero setting and with scale adjustment facilities.

The scale adjustment shall neither influence the adjusted zero nor the linearity of the system.

4.1.6 Sample handling system

All components of the gas-handling system shall be made of corrosion-resistant material; in particular the material of the sampling probe shall also withstand the exhaust gas temperature. The design and the materials of the equipment shall not influence the composition of the gas sample.

4.1.7 Water removal system

The gas-handling system shall contain a water separator which prevents water condensation in the measuring transducer. In the case of saturation of the separator, the operation shall be automatically stopped.

4.1.8 Probe

The probe design shall be such that it will not slip out of the motor vehicle exhaust pipe when in use for analysis. The probe shall be at least 300 mm long, flexible enough to be introduced into the tail-pipe, and robust enough to withstand being driven over or trodden on.

4.1.9 Filter system

The gas-handling system shall contain a filter unit with reusable or replaceable filter elements capable of removing particles in excess of 5 µm. It shall be possible to observe the filter contamination and to replace the filter easily without tools and without the risk of leakage.

4.1.10 Pump system

The pump conveying the exhaust gas shall be mounted so that it does not cause vibrations which affect the measurements. It shall be possible to turn the pump off without affecting the main power supplying circuit.

4.1.11 Low flowrate protection

The analyser shall be equipped with a device, which, when a drop of the gas flowrate reaches a level which causes the analysis to exceed the response time or the maximum permissible error on verification, interrupts measurement readings.

4.1.12 Measuring ranges

The recommended analyser measuring ranges are specified in clause 1 of each annex.

4.1.13 Analyser accuracy

The accuracy of the analyser shall meet the requirements of clause 1 of each annex.

4.1.14 Repeatability

After 20 consecutive measurements, the repeatability shall be equal to or less than 2 %.

4.1.15 Zero and scale drift

During 4 h of operation, zero and scale drift of a warmed analyser shall not be greater than

— twice the maximum permissible error, for type A;

— maximum permissible error, for type B.

Automatic compensation may be used.

4.1.16 System response time

The analyser concentration indication shall reach 90 % of the final stabilized reading within 10 s after starting exhaust gas sampling at the sample probe inlet.

4.1.17 Measuring indicator

The volume fractions on the gas components shall be indicated in percentage or in parts per million (ppm) according to clause 1 of each annex.

The specification "% vol (gas)" and "ppm vol (gas)" shall be unambiguously assigned to the indication.

For type A, the scale shall be as linear as possible. For type B, the scale shall be linear.

4.1.18 Fault detection

The analyser shall be equipped with checking facilities to detect faults due to disturbances. These checking facilities may be either automatic or non-automatic. Upon detection of a fault, the analyser shall produce a signal to warn the operator. It shall be possible to check the presence and to determine the correct functioning of the checking facilities.

4.1.19 Detecting gas residues

Hydrocarbon analysers shall be equipped with a facility for detecting hydrocarbon gas residues, which serves to ascertain whether the value indicated is less than 20 ppm *n*-hexane when an ambient air sample is taken through the probe.

4.1.20 Ambient temperature conditions

The analyser shall be suitable for use at ambient temperatures between 278 K and 313 K.

4.1.21 Ambient pressure conditions

The analyser shall be suitable for use at ambient pressures between 86 kPa and 106 kPa.

4.1.22 Ambient relative humidity conditions

The analyser shall be suitable for use at ambient relative humidities between 10 % and 95 %.

4.1.23 Safety requirements

The construction (materials and electrical systems used in the analyser) shall comply with local safety

requirements. The analyser shall incorporate safety devices for the protection of personnel and nearby equipment.

4.1.24 Controls

The scale and zero controls shall be ready accessible but protected against unintentional adjustment.

4.1.25 Warm-up time

The analyser warm-up time shall not exceed 30 min.

4.1.26 Data output

For type A, the requirements applicable to type B analysers are recommended.

For type B, the analyser shall be equipped with output suitable for data printing or computer processing (i.e. as RS 423 or RS 232 C). The data output shall be so designed that the transmitted data cannot be falsified. If a checking facility detects a fault or a malfunction of the analyser, the data transmission shall be interrupted.

4.2 Influencing factors

4.2.1 Interference of other gases

The accuracy of the measurement shall not be influenced by more than 1,5 times the maximum permissible error by other gas components present as interference gas mixtures defined in clause 3 of each annex. Each single gas of interference gas mixtures, with the same concentration, defined in clause 3 of each annex may be used. In this case the sum of the errors shall not be more than 1,5 times the maximum permissible error of the values measured.

4.2.2 Interference of water-vapour-saturated gas

The accuracy of the measurement shall not be influenced by more than 1,5 times the maximum permissible error by water-vapour-saturated gas.

4.2.3 Temperature

At extreme stable temperatures, defined in 4.1.20, the accuracy of the analyser shall not exceed the maximum permissible error.

4.2.4 Pressure

At extreme stable ambient pressures, defined in 4.1.21, the accuracy of the analyser shall not exceed the maximum permissible error.

4.2.5 Relative humidity

At extreme stable ambient relative humidity values, defined in 4.1.22, the accuracy of the analyser shall not exceed the maximum permissible error.

4.2.6 Supply voltage

The accuracy of the analyser, operating under an electrical power supply voltage variation of ± 10 %, shall not exceed

— 1,5 times the maximum permissible error, for type A;

— the maximum permissible error, for type B.

4.2.7 Supply frequency

The accuracy of the analyser, operating under an electrical power supply frequency variation of ± 2 Hz shall not exceed

— 1,5 times the maximum permissible error, for type A;

— the maximum permissible error, for type B.

4.2.8 Electromagnetic disturbances

The accuracy of the analyser, operating under electromagnetic radiation or conductive interference produced by the vehicle ignition system and/or building electric systems, shall not exceed 1,5 times the maximum permissible error.

4.2.9 Vibration and shock protection

The accuracy of the analyser shall not be affected by more than 1,5 times the maximum permissible error by vibration and shock encountered under normal operating conditions.

5 Verification procedure

5.1 General

5.1.1 Control conditions

For verification of the technical requirements of an analyser, the ambient conditions shall be as follows:

— temperature: 293 K ± 2 K

— relative humidity: (65 ± 5) %

— atmospheric pressure: stable, within ± 2,5 kPa

5.1.2 Measurement accuracy

Measurement accuracies shall be as follows:

Temperature:	± 2 K
Pressure:	± 1 kPa
Relative humidity:	± 5 %
Time:	± 1 s

5.1.3 Calibration gases

The calibration gases shall be those defined in clause 2 of each annex.

The interference gases shall be those defined in clause 3 of each annex.

5.2 Measuring range

Check that the indicator of the analyser is in accordance with the requirements of clause 1 of each annex.

5.3 Accuracy

5.3.1 Under control conditions

Following the warm-up time and the adjustment procedure as described by the manufacturer, introduce a calibration gas into the analyser through the sampling inlet.

Verify the accuracy of the analyser at least at three points of each scale range (included 0 and 80 % of the full scale): the other value(s) shall be uniformly distributed.

After 60 s of stabilization, verify conformity with the requirements of 4.1.13.

Each measurement shall be repeated at least twice.

At the end of the test, if necessary, adjust the analyser and in this case repeat the whole test.

5.3.2 Under extreme stabilized conditions

Following the warm-up time and the adjustment procedure as described by the manufacturer, the test consists in introducing a calibration gas into the analyser, through the sampling inlet, under the requirements of 4.1.20 to 4.1.22.

After 60 s of stabilization, verify conformity with the requirements of 4.1.13 and 4.2.

Each measurement shall be repeated at least twice.

At the end of the test, if necessary, adjust the analyser and in this case repeat the whole test.

5.4 Repeatability

After 20 consecutive measurements, the following relation shall be satisfied:

$$\frac{100t\sigma}{\sqrt{20}\,\bar{x}} \leqslant 2\ \%$$

where

t = 2,2 (corresponds to 20 measurements);

σ is the standard deviation;

$\bar{x}$ is the arithmetic average of the 20 measurements.

For each consecutive measurement carried out under control conditions or extreme stabilized condition requirements defined in 4.1.20 to 4.1.22, the same calibration gases shall be used by the same operator with the same analyser at relatively short time intervals.

5.5 Zero and scale drift

Following the warm-up time and the adjustment procedure as described by the manufacturer, introduce a zero gas and a calibration gas into the analyser through the sampling inlet, under control conditions or extreme stabilized condition requirements as defined in 4.1.20 to 4.1.22.

Perform measurements of the calibration gases at least every hour for 8 h to verify the conformity with 4.1.15.

5.6 Response time

Under control conditions verify the time necessary for the analyser to reach 90 % of the calibration gas concentration value after the sampling zero gas is supplied at the probe.

A means for instantly changing from the sampling zero gas to the sampling calibration gas through the probe shall be employed.

The calibration gas and the zero gas are supplied to the probe in a manner that the pressure, at the probe, shall not be increased or decreased by more than 750 Pa from ambient pressure.

The results of the measurement shall conform to the requirements of 4.1.16.

5.7 Ambient temperature variation influence

After the warm-up time and the adjustment procedure as described by the manufacturer, carry out the following steps:

a) under control conditions (5.1.1), make at least three measurements of calibration gases;

b) calculate the mean value of the measurements;

c) get the ambient temperature to the lowest extreme temperature specified in 4.1.20, in 2 h.

d) stabilize the analyser at the lowest extreme temperature for 30 min;

e) make at least three measurements of the calibration gases;

f) calculate the mean value of the measurements;

g) get the ambient temperature to the highest extreme temperature specified in 4.1.20, in 2 h;

h) stabilize the analyser at the highest temperature for 30 min;

i) repeat points e) and f);

j) compare the three mean values.

The difference between the highest and lowest mean values shall not exceed

— twice the maximum permissible error, for type A;

— 1,7 times the maximum permissible error, for type B.

During the test the ambient temperature and the ambient pressure shall be those indicated for control conditions (5.1.1).

5.8 Ambient pressure variation influence

After the warm-up time and the adjustment procedure, as described by the manufacturer, carry out the following steps:

a) under control conditions (5.1.1), carry out at least three measurements of calibration gases;

b) calculate the mean value of the measurement;

c) get the ambient pressure to the lowest extreme pressure specified in 4.1.21, in 2 h;

d) stabilize the analyser at the lowest extreme ambient pressure for 30 min;

e) make at least three measurements of the calibration gases;

f) calculate the mean value of the measurement;

g) get the ambient pressure to the highest extreme pressure specified in 4.1.21, in 2 h;

h) stabilize the analyser at the highest ambient pressure for 30 min;

i) repeat points e) and f);

j) compare the three mean values.

The difference between the highest and lowest mean values shall not exceed

— twice the maximum permissible error, for type A;

— 1,7 times the maximum permissible error, for type B.

During the test the ambient temperature and ambient relative humidity shall be those indicated for control conditions (5.1.1).

5.9 Ambient relative humidity variation influence

After the warm-up time and the adjustment procedure as described by the manufacturer, carry out the following steps:

a) under control conditions, (5.1.1) make at least three measurements of calibration gases;

b) calculate the mean value of the measurements;

c) get the ambient relative humidity to the lowest extreme relative humidity specified in 4.1.22, in 2 h;

d) stabilize the analyser at the lowest extreme relative humidity for 30 min;

e) make at least three measurements of the calibration gases;

f) calculate the mean value of the measurements;

g) get the ambient relative humidity to the highest extreme relative humidity specified in 4.1.22, in 2 h;

h) stabilize the analyser at the highest relative humidity for 30 min;

i) repeat points e) and f);

j) compare the three mean values.

The difference between the highest and lowest mean values shall not exceed

— twice the maximum permissible error, for type A;

— 1,7 times the maximum permissible error, for type B.

During the test the ambient temperature and the ambient pressure shall be those indicated for control conditions (5.1.1).

5.10 Warm-up time

Under control conditions, make at least three measurements of calibration gases. Carry out the following steps:

a) stabilize the analyser in the switched off condition;

b) switch on the analyser;

c) let the analyser warm up for the period declared by the manufacturer or for the maximum period defined in 4.1.25;

d) calibrate the analyser as described by the manufacturer;

e) make at least three measurements of the calibration gas;

f) calculate the mean values of the measurements;

The calculated mean value shall conform to the requirements of 4.1.13.

5.11 Interference of other gases

Under control conditions (5.1.1), make at least three measurements of calibration gases. Carry out the following steps:

a) after the warm-up time, check the analyser three times as described by the manufacturer;

b) calculate the mean value of the measurements of the calibration gas;

c) introduce the interference gas mixtures into the analyser through the sampling inlet three times;

d) calculate the mean value of the measurements of the interference gas mixtures.

The results shall conform to the requirements of 4.2.1.

5.12 Interference of water-vapour-saturated gas

Under control conditions (5.1.1), make at least three measurements of calibration gases. Carry out the following steps:

a) after the warm-up time, calibrate the analyser three times as described by the manufacturer;

b) calculate the mean value of the measurements of the calibration gas;

c) connect the sampling inlet of the analyser to an impinger (gas bubbler) with water;

d) introduce the calibration gas into the analyser through the impinger;

e) check the bubbling of the calibration gas through the water;

f) calculate the mean value of the measurements of the calibration gas influenced by water-vapour-saturated air.

The results shall conform to the requirements of 4.2.2.

5.13 Supply voltage and frequency

Under control conditions (5.1.1), make at least three measurements of calibration gases. Carry out the following steps:

a) after the warm-up time, adjust the analyser as described by the manufacturer;

b) introduce the calibration gas into the analyser through the sampling inlet;

c) submit the analyser to the lowest values of voltage and frequency defined in 4.2.6 and 4.2.7;

d) after a period of stabilization of 30 s, make at least three measurements of the calibration gas;

e) calculate the mean value of the measurements;

f) submit the analyser to the highest values of voltage and frequency defined in 4.2.6 and 4.2.7;

g) after a period of stabilization of 30 s, make at least three measurements of the calibration gas;

h) calculate the mean value.

The results shall conform to the requirements of 4.2.6 and 4.2.7.

5.14 Electromagnetic disturbances

Under control conditions (5.1.1) and in accordance with IEC 801-2, IEC 801-3 and IEC 801-4, the results of the measurements of the calibration gas shall conform to the requirements of 4.2.8.

5.15 Vibrations and shock protection

Under control conditions (5.1.1), make at least three measurements of the calibration gas. Place the analyser in its normal orientation of use on a rigid surface. Tilt it on one bottom edge to at most 30° and then

allow it to fall on the test surface, under the following conditions:

— height of fall: 25 mm[2)]

— number of falls: 2

Repeat the test on each bottom edge.

Before and after this test, measure the zero and scale drifts in accordance with 5.4.

The result of the measurements shall conform to the requirements of 4.2.9.

2) Distance between the elevated edge of the analyser and the test surface.

Annex A
(normative)

Carbon monoxide and carbon dioxide analyser

A.1 Analyser specifications

The analyser specifications for carbon monoxide (CO) and carbon dioxide (CO_2) are indicated in table A.1.

Table A.1 — Specifications of CO and CO_2 analysers

Type	Meter	Gas	Recommended scale range[1] % (*V/V*)	Recommended resolution % (*V/V*)	Maximum permissible error[2]	
					relative[3] %	absolute % (*V/V*)
A	analog	CO	0 to 7 [4]	0,2 max.	± 5	± 0,15
		CO_2	0 to 16	0,4	± 5	± 0,5
	digital	CO	0 to 10 [4]	0,1	± 5	± 0,15
		CO_2	0 to 16	0,1	± 5	± 0,5
B	analog	CO	0 to 1 0 to 3 [5] [6]	0,02 0,05	± 5	± 0,03 ± 0,05
		CO_2	0 to 16	0,2	± 5	± 0,3
	digital	CO	0 to 1 [4] 0 to 3 [5] [6]	0,01 0,01	± 5	± 0,03 ± 0,05
		CO_2	0 to 16	0,1	± 5	± 0,3

1) The scale range can be subdivided into subranges; in digital analysers, subranges are not always necessary.
2) Whichever is the greater of the two errors.
3) Values of relative error are indicated as a percentage of the measured value.
4) Maximum scale range.
5) The scale shall be manually selected and the selector shall show clearly the selected scale.
6) This range is not applicable for readings below 1 %.

A.2 Calibration gases

Concentrations shall be about 80 % of the full scale range under consideration and the accuracy shall be of ± 2 % in N_2 as a complement. If necessary, other(s) concentration(s) may be used in addition.

A.3 Interference gas mixtures

The recommended interference gas mixtures in N_2 are indicated in table A.2.

Table A.2 — Recommended interference gas mixture in N_2

Measurand	Type A			Type B		
	CO [1]	CO_2	HC [2]	CO [1]	CO_2	HC [2]
CO, CO_2	80 %	14 %	1 600 ppm	80 %	14 %	160 ppm
CO, CO_2	300 ppm of NO					

NOTE — The accuracy of the components of the gas mixtures in N_2 are:

CO: ± 2 %

CO_2: ± 2 %

HC: ± 2 %

NO: ± 2 %

1) As a percentage of full scale

2) In equivalent hexane (C_6H_{14})

Annex B
(normative)

Hydrocarbon analyser

B.1 Analyser specifications

The hydrocarbon (HC) analyser specifications are indicated in table B.1.

B.2 Calibration gases

Concentrations shall be about 80 % of the full scale range under consideration and the accuracy shall be of ± 2 % in N_2 as a complement. If necessary, other(s) concentration(s) may be used in addition.

B.3 Interference gas mixtures

The recommended interference gas mixtures in N_2 are indicated in table B.2.

Table B.1 — Specifications of hydrocarbon analysers

Type	Meter	Gas[1]	Recommended scale range[2] ppm (*V*/*V*)	Recommended resolution ppm (*V*/*V*)	Maximum permissible error[3] relative[4] %	Maximum permissible error[3] absolute ppm (*V*/*V*)
A	analog	HC	0 to 2 000	50	± 5	± 20
	digital			10		
B	analog	HC	0 to 200	10	± 5	± 10
	digital			2		

1) HC = hydrocarbons, in equivalent hexane (C_6H_{14})
2) The scale range can be subdivided into subranges; in digital analysers subranges are not always necessary.
3) Whichever is the greater of the two errors.
4) All values of relative error are indicated as relative values to the measured value.

Table B.2 — Recommended interference gas mixture in N_2

Measurand	Type A			Type B			
	HC [1]	CO_2	CO	HC [1]	CO_2	CO	O_2
HC [2]	80 %	14 %	3 %	80 %	14 %	3 %	5 %
	300 ppm of NO						

NOTE — The accuracy of the components of the gas mixtures in N_2 are:

CO: ± 2 %

CO_2: ± 2 %

HC: ± 2 %

O_2: ± 2 %

1) As a percentage of full scale
2) In equivalent hexane (C_6H_{14})

Annex C
(normative)

Oxygen analysers

C.1 Analyser specifications

The oxygen analyser specifications are indicated in table C.1.

C.2 Calibration gases

Concentrations shall be about 80 % of the full scale range under consideration and the accuracy shall be of ± 2 % in N_2 as a complement. If necessary, other(s) concentration(s) may be used in addition.

C.3 Interference gas mixtures

The recommended interference gas mixtures in N_2 are indicated in table C.2.

Table C.1 — Oxygen analyser specification

Type	Meter	Gas	Recommended scale range[1] % (*V/V*)	Recommended resolution % (*V/V*)	Maximum permissible error[2] relative[3] %	Maximum permissible error[2] absolute % (*V/V*)
A	not applicable					
B	analog	O_2	0 to 6 0 to 21	0,1 0,2	± 5	± 0,2 ± 0,3
	digital		0 to 6 0 to 21	0,01 0,1	± 5	± 0,2 ± 0,3

1) The scale range can be subdivided into subranges; in digital analysers subranges are not always necessary.
2) Whichever is the greater of the two errors.
3) All values of relative error are indicated as relative values % to the measured value.