



## Safety of machinery — Evaluation of the emission of airborne hazardous substances —

### Part 2:

### Tracer gas method for the measurement of the emission rate of a given pollutant

*Sécurité des machines — Évaluation de l'émission de substances dangereuses véhiculées par l'air —*

*Partie 2: Méthode par gaz traceur pour le mesurage du taux d'émission d'un polluant donné*

ICS 13.110

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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 29042-2 was prepared by Technical Committee ISO/TC 199 – *Safety of machinery*.

ISO 29042 consists of the following parts, under the general title *Safety of machinery — Evaluation of the emission of airborne hazardous substances*:

- *Part 1: Selection of test methods* <sup>1)</sup>
- *Part 2: Tracer gas method for the measurement of the emission rate of a given pollutant*
- *Part 3: Test bench method for the measurement of the emission rate of a given pollutant* <sup>1)</sup>;
- *Part 4: Tracer method for the measurement of the capture efficiency of an exhaust system* <sup>1)</sup>;
- *Part 5: Test bench method for the measurement of the separation efficiency by mass of air cleaning systems with unducted outlet* <sup>1)</sup>;
- *Part 6: Test bench method for the measurement of the separation efficiency by mass of air cleaning systems with ducted outlet* <sup>1)</sup>;
- *Part 7: Test bench method for the measurement of the pollutant concentration parameter* <sup>1)</sup>;
- *Part 8: Room method for the measurement of the pollutant concentration parameter* <sup>1)</sup>;
- *Part 9: Decontamination index* <sup>1)</sup>.

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1) In preparation.

## Introduction

The structure of safety standards in the field of machinery is as follows:

- **Type-A standards** (basic safety standards) giving basic concepts, principles for design, and general aspects that can be applied to all machinery;
- **Type-B standards** (generic safety standards) dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:
  - Type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);
  - Type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure sensitive devices, guards);
- **Type-C standards** (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This part of ISO 29042 is a type-B standard as stated in ISO 12100-1.

The provisions of this document can be supplemented or modified by a type-C standard.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of the type-C standard.

ISO/TC 199 has a mandate in this area to produce type-A and type-B standards, which will allow verification of conformity with the essential safety requirements.

ISO 29042-2 is based on EN 1093-2:2006, published by the European Committee for Standardization (CEN).

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# Safety of machinery — Evaluation of the emission of airborne hazardous substances — Part 2: Tracer gas method for the measurement of the emission rate of a given pollutant

## 1 Scope

This document specifies a method to enable measurements of the emission rates of gaseous substances from a single machine, whose operation can be controlled, using tracer gas techniques.

This document is not applicable to machinery which are manufactured before the date of its publication as ISO.

## 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 12100-1:2003, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

ISO 29042-1<sup>1)</sup>, *Safety of machinery – Evaluation of the emission of airborne hazardous substances – Part 1: Selection of test methods*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100-1:2003, ISO 29042-1 and the following apply.

### 3.1

#### tracer gas technique

the use of gaseous substances with an aerodynamic behaviour comparable with the gaseous hazardous substance under consideration and for which concentrations can be reliably measured

## 4 Principle

The principle is based on the use of a tracer gas generated at a known and constant emission rate to provide the best representation of the pollutant source. The mean tracer gas and pollutant concentrations are measured in the vicinity of the source. Assuming that the aerodynamic behaviour of the pollutant is equal to that of the tracer gas, the pollutant emission rate can be determined.

## 5 Location of the machine

### 5.1 General

The method is intended for use for a machine located either in a test room or in the field.

### 5.2 Test room method

The general airflow patterns in the test room should be characterised to enable more precise control of the general and local ventilation to be achieved. The machine should be placed in the centre of the room.

### 5.3 Field method

Many machines cannot be tested in a test room because they are too large, too difficult to handle or have special installation or process requirements. Tests may be performed on machines in the places where they are installed, i.e. the workplace. For this purpose, it shall be ensured that pollutants from other emission sources present in the room shall not affect the measurements of the concentrations of the specific pollutant emitted from the machine under test.

## 6 Apparatus and materials

**6.1 Tracer gas emitter**, capable of providing a release of the tracer gas in the same manner as the pollutant emission.

The shape of the emitter should resemble the shape of the real pollutant source. A distinction is generally drawn between:

- point sources (e.g. welding operations, localised leaks from gaskets, flanges, localised spraying, such as painting jet);
- plane sources (e.g. open vessel or tank containing liquid or melted solid liable to evaporate or sublimate, such as galvanising baths, electroplating baths);
- volumetric sources (e.g. closed machine with distributed leaks, rubber making machine, printing machine, degreaser, dry cleaning machine, diffuse spraying, such as plant-care products in agriculture).

Point sources should be simulated by opened tubes producing jets of variable aerodynamic characteristics or by sintered materials diffusing the tracer gas at a low initial velocity. Plane and volumetric sources should be simulated by a network of point sources or perforated tubes, which are suitably distributed.

**6.2 Tracer gas flow rate measuring device**, capable of measuring tracer gas flow rates in the appropriate range.

NOTE The tracer gas flow rate depends on the sensitivity of the tracer gas analyser. For most applications a device calibrated to measure flow rates in the range from 1 l min<sup>-1</sup> to 10 l min<sup>-1</sup> is suitable.

**6.3 Tracer gas flow rate adjusting device**, e.g. a valve.

**6.4 Gas analyser(s)**, preferably direct reading.

An alternative method of measuring the pollutant concentration is to collect the gas on vapour absorption tubes for later analysis, in the laboratory, using gas analyser(s).

The gas analyser(s) should be selected to avoid any interference from any chemical substances present, other than the pollutant and tracer gas, in the test room or workplace where the machine under test is situated. Calibrations shall be carried out according to European or International Standards.



NOTE The choice of gas analyser depends upon the tracer gas and pollutant to be measured. Suitable analysers include infrared, electron capture, FID analysers, or mass spectrometer. Their performances should be checked before use. The analysers used should not be susceptible to change in environmental conditions such as temperature and relative humidity.

**6.5 Connecting piping**, for connection of the sampled tracer gas and pollutant gas to the analysers.

The piping length should be as short as possible and the material chosen to limit adsorption on the piping walls e.g. PTFE. If the machine is located in a dirty workplace atmosphere particle filters should be fitted. For adsorption tubes the piping length upstream should be shorter.

**6.6 Tracer gas**; it shall be selected in accordance with the following criteria:

- a) nil or very low toxicity;
- b) chemical stability at the intended process temperature;
- c) easily measurable at low concentrations;
- d) non-interference with pollutants present in the room;
- e) low background level.

The tracer gas chosen should have a relative density close to 1. The tracer gas can be mixed with an appropriate gas.

NOTE The choice of the tracer gas and associated analyser depends, in particular, on the desired accuracy, the measurement range, and the cost. The gases normally used are helium, sulphur hexafluoride, and nitrous oxide.

## 7 Measurement points

There should be at least three measurement points around the machine (see Figure 1). These should be positioned close to the machine, e.g. between 1 m and 3 m, and at the height where the pollutant is generated. At each measurement point both tracer gas and pollutant concentrations are measured. The measurement points should be determined by pre-testing to ensure that they are in zones of measurable emission.