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# Soil quality — Sampling —

## Part 204: Guidance on sampling of soil gas

*Qualité du sol — Échantillonnage —*

*Partie 204: Lignes directrices pour l'échantillonnage des gaz de sol*

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 2, *Sampling.*

This first edition of ISO 18400-204 cancels and replaces ISO 10381-7:2005, which has been technically and structurally revised. The ISO 18400 series is based on a modular structure and cannot be compared to ISO 10381-7 clause by clause.

A list of all parts in the ISO 18400 series can be found on the ISO website.

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# Introduction

This document is one of a group of International Standards to be used in conjunction with each other where necessary. The ISO 18400 series deals with sampling procedures for the various purposes of soil investigation. The roles/positions of the individual standards within the total investigation programme are shown in Figure 1. The stated soil gas and landfill-gas measurements do not give any quantitative statement of the total quantity of material detected in soil gas or soil. The measurement results can be influenced by, e.g. temperature, humidity, air pressure, minimum extraction depth, etc.

The general terminology used is in accordance with that established in ISO/TC 190 and, more particularly, with the vocabulary given in ISO 11074.

Toxic, asphyxiating and explosive soil gases can enter buildings and other built development on and below ground and variously pose potential risks to occupants and users and to the structures themselves.

Such gases might be present in the ground naturally, or be present as a result of contamination of the ground, or arise from buried wastes. In addition to the main components found in air (nitrogen and oxygen), soil gas can contain volatile organic compounds (VOCs), inorganic vapours (e.g. mercury) and a wide range of other gases (e.g. methane, carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia, helium, neon, argon, xenon, radon, etc.).

These gases can have several origins such as: landfilled wastes; contaminated soils on a brownfield site; plume of contaminated groundwater; spill or leakage of chemicals products, leaks of mains gas (natural gas); sewer gas, etc.

In order to complete an assessment of the risks posed by the presence of permanent and other soil gases like VOCs, it is necessary to understand and characterize the potential sources of gas in and around a site.

Guidance on installations for soil gas sampling (equipment and instruments, methods of sampling, requirements of controls, etc.) and other relevant information (e.g. on environmental conditions) are provided in this document.


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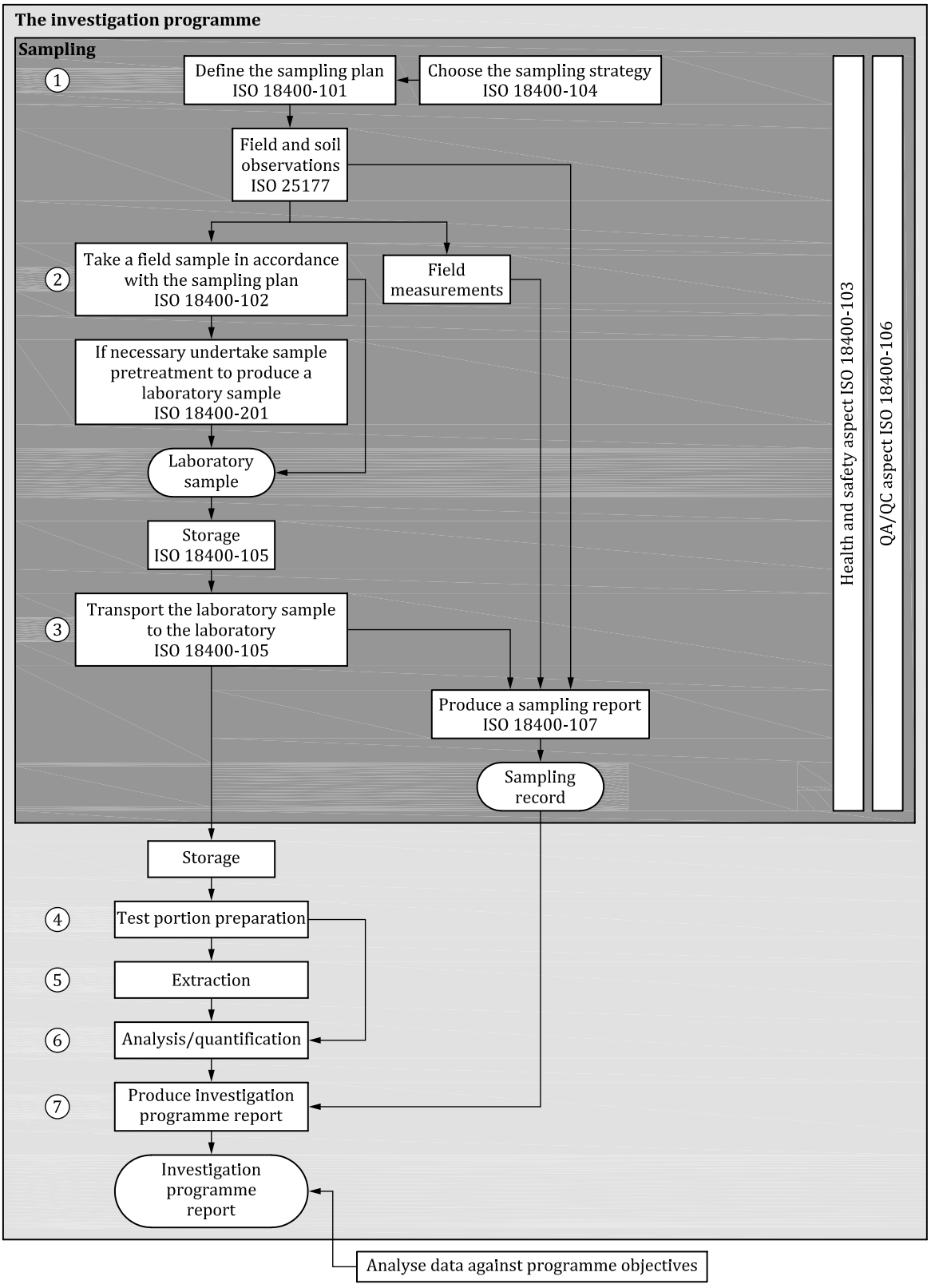



**Figure 1 — Links between the essential elements of an investigation programme**

NOTE 1 The numbers in circles in Figure 1 define the key elements (1 to 7) of the investigation programme.

NOTE 2 Figure 1 displays a generic process which can be amended when necessary.

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# Soil quality — Sampling —

# Part 204: Guidance on sampling of soil gas

## 1 Scope

This document contains guidance on soil gas sampling using

— active sampling (adsorbents, filters, air containers), and

— passive sampling

applied at permanent or temporary monitoring wells or other installations in soils or underneath buildings (sub-slab).

It provides guidance on:

— development of a sampling plan;

— construction of monitoring installations;

— transport, packaging and storage soil gas samples;

— quality assurance.

This document also gives basic information about

— soil gas dynamics, and

— identification of soil gas sources

relevant to permanent or temporary boreholes in soils or underneath buildings (sub-slab).

The compounds covered by this document are:

— volatile organic compounds (VOCs);

— inorganic volatile compounds (e.g. mercury, HCN);

— permanent gases (i.e. $CO_2$, $N_2$, $O_2$, $CH_4$).

This document does not give guidance on:

— risk evaluation and characterization;

— selection and design of protective measures;

— the verification of protective measures, although the site investigation methodologies described can be used when appropriate;

— the sampling of atmospheric or indoor gases;

— the measurement of gases from the soil entering into the atmosphere;

— monitoring and sampling for radon.

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## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 11074, *Soil quality — Vocabulary*

ISO 18400-107, *Soil quality — Sampling — Part 107: Recording and reporting*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11074 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

**3.1**
**active soil gas sampling**
sampling by extracting a certain volume of soil gas

**3.2**
**breakthrough**
detection of an adsorbent control section of one or more compounds having a mass greater than 5 % of the mass quantified on the measuring section

**3.3**
**dead volume**
volume which is present between the suction opening of the soil gas probe and the sampling vial, including the volume of the sampling vial or of the adsorption tube

**3.4**
**dense non aqueous phase liquid**
**DNAPL**
liquid of a group of organic substances which is relatively insoluble in the water and denser than the water

**3.5**
**direct method**
**direct measuring method**
method of analysis where the soil gas sample (aliquot) is directly introduced into a suitable equipment without first being concentrated and subjected to analysis

**3.6**
**direct-reading detecting tube**
glass tube filled with reagents which, after drawing through certain gaseous compounds, show concentration-dependent chromophoric reactions and which are thus used for qualitative and semi-quantitative analyses as well

Note 1 to entry: It is important that attention be paid to cross-sensitivities.

**3.7**
**gas migration**
movement of gas from the source through the ground to the adjoining strata or to emit to atmosphere

Note 1 to entry: Examples of sources include e.g. wastes within a landfill or spill of hydrocarbons.


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**3.8**
**gas monitoring well**
standpipe suitably installed inside a borehole from which gas samples can be taken to measure soil gas concentrations and to monitor changes in composition of soil gas or soil *gas migration* (3.7)

**3.9**
**gas sampling**
collection of a volume of soil gas contained in the pore space of the soil

**3.10**
**landfill**
deposition of waste into or onto the land as a means of disposal

**3.11**
**landfill gas**
mixture of permanent gases (main components), dominated by methane and carbon dioxide, formed by the decomposition of degradable wastes within landfill sites

Note 1 to entry: It can also include a large number of VOCs (trace components).

**3.12.1**
**lower explosive limit**
**LEL**
lowest percentage (volume fraction) of a mixture of flammable gas with air which will propagate an explosion in a confined space at 25 °C and atmospheric pressure

**3.12.2**
**upper explosive limit**
**UEL**
uppermost percentage (volume fraction) of a mixture of flammable gas with air which will propagate an explosion in a confined space at 25 °C and atmospheric pressure

**3.13**
**light non aqueous phase liquid**
**LNAPL**
liquid of a group of organic substances which is relatively insoluble in the water and less dense than the water

**3.14**
**method by adsorption**
method in which substances to be determined are concentrated adsorptively on an adsorbent, subsequently desorbed and analysed

Note 1 to entry: The adsorbent can be e.g. activated charcoal or XAD-4 resin.

**3.15**
**monitoring installation**
permanent or temporary device used for soil gas sampling

EXAMPLE Sub-slab, soil gas probe.

**3.16**
**non aqueous phase liquid**
**NAPL**
liquid of a group of organic substances which is relatively insoluble in the water

**3.17**
**one-stage soil gas sampling**
sampling of soil gas directly from a soil gas probe placed in soil, without pre-drilling

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**3.18**
**passive soil gas sampling**
sampling based on the adsorption of gases of the ground on an adsorbent placed in the ground, without using artificially reduced pressure

**3.19**
**permanent gas**
element or compound that is a gas at all ambient temperatures likely to be encountered on the surface of the earth

EXAMPLE Gas like mine and landfill gases.

Note 1 to entry: Permanent gas can also be defined as "element or compound that is a gas at all ambient temperatures likely to be encountered on the surface of the earth"; see ISO 11074:2015, 3.6.11.

**3.20**
**soil gas**
gas and vapour in the pore spaces of soils

**3.21**
**soil gas monitoring device**
borehole finished with suitable material for stabilisation of the borehole wall and/or for limiting the sampling area

Note 1 to entry: Depending on the type and stability of fitting, a distinction is made between temporary (for single or short-term repeated soil sampling) and stationary and semi-permanent or permanent soil gas monitoring points (for long-term observation).

**3.22**
**soil gas probe**
**soil gas sampling probe**
probe, generally a tube, which is installed directly into soil (one-stage soil gas sampling), or in a borehole (two-stage soil gas sampling) to take soil gas samples

Note 1 to entry: By applying a negative pressure to the upper end of the soil gas probe (head), the soil gas at the lower end (tip) is drawn through the suction opening(s) and transferred to a gas collecting equipment and online measurement equipment (direct measuring method) or to an absorbent (concentration method), which are installed either in or at the head of the soil gas probe or subsequently used.

**3.23**
**soil gas sample volume**
volume of soil gas taken to form the sample

**3.24**
**continuous soil gas sampling**
sampling from a monitoring well over a controlled longer period of time (mostly several hours up to days) to observe the variations over time of the gas concentrations and of the pressure distribution in the soil

**3.25**
**sub-slab**
soil gas sampling location just below the foundation slab of a building, within the unsaturated zone

**3.26**
**subsoil**
layer of soil beneath the surface soil and overlying the bedrock (called also "undersoil")

**3.27**
**two-stage soil gas sampling**
sampling done firstly through installation of a borehole with the aid of a drilling instrument or by small boring, and secondly by sampling of soil gas from a soil gas probe installed in the borehole


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**3.28**
**volatile organic compound**
**VOC**
organic compound that is volatile under normal environmental/atmospheric conditions, although it can be found in the ground in the solid, liquid and dissolved phase form as well as in gaseous phase

Note 1 to entry: VOC can also be defined as "organic compound" which is liquid at room temperature (20 °C), which generally has a boiling point below 180 °C"; see ISO 11074:2015, 6.1.24.

Note 2 to entry: Examples include single-ring aromatic hydrocarbons and other low boiling halogenated hydrocarbons, which are used as solvents or fuels, and some degradation products.

## 4 Preliminary items to be considered

Soil vapour monitoring is a faster and cheaper method to detect contamination of VOCs in soils and/or in groundwater and for mapping the plumes than soil boreholes and/or the installation of groundwater monitoring wells. The method permits establishment of a much denser network of soil gas monitoring points than is usually possible for groundwater monitoring wells and soil boreholes.

The choice of sampling technique should be consistent with the requirements of the investigation (including subsequent analytical procedures, conceptual site model, investigation objectives, etc.). Consideration should also be given to the nature of ground under investigation, as well as the nature and distribution of contamination, the geology and the hydrogeology. Every effort should be made to avoid cross-contamination and creation of preferential pathways to avoid contamination of underlying aquifers.

Before intrusive works begin, a comprehensive check should be made of the ground to ensure that no services or structures are at risk and no hazards are present (for more information on sampling techniques and safety, see ISO 18400-102 and ISO 18400-103).

When sampling soil gas close to the surface, the effect of ambient air penetration needs to be considered. The sampling depth is determined by the presence of impermeable cover over the ground surface, the soil type (porosity, clay content, etc.) and the depth of bedrock.

NOTE 1 A preliminary condition for soil gas sampling and monitoring is the prior recording of the geological soil profiles/pedological layers. For some sites, this can be done whilst taking soil samples from borings.

Cold conditions make soil gas sampling difficult in many ways. Ground frost greatly limits the mobility of gas in soil and should be considered in planning and carrying out sampling as well as in interpreting the measurements results. Water saturation (total or partial) of unsaturated layer (e.g. after rainfall) can significantly reduce the soil gas emission rates, limit soil gas mobility, and lead to high levels of humidity can severely reduce the adsorption capacity of some sorbents.

The main problem with soil gas sampling below the frozen ground is the loss of air-filled porosity due to the high moisture content in the zone between frozen and unfrozen parts of the ground. Consequently, the samples should be taken from greater depths (but compatible with investigation objectives).

All buildings constructed on unfrozen ground act as pathways or barriers for upwards soil gas migration. Lower pressures and differences in concentration in the buildings can also assist gases to penetrate the basements of buildings.

NOTE 2 Causes of differential pressure effects include the rise of warm air within buildings and the operation of air-conditioning systems. Gas can enter through:

— cracks and openings in concrete ground slabs such as cracks due to shrinkage;

— construction joints/openings, e.g. at wall/foundation interface with ground slab;

— cracks in walls below ground level present due for example to shrinkage or movement;

— gaps and openings in suspended concrete or timber floors;

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