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Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 April 2013. It was prepared by Technical Committee EH/4, *Soil Quality*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

This standard is intended to be read in conjunction with BS 10175, *Investigation of potentially contaminated sites – Code of practice*.

Test laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

This standard, which is intended to be used in conjunction with BS 10175, provides guidance on the monitoring and sampling of ground gases. It covers volatile organic compounds (VOCs) and permanent gases such as carbon dioxide, methane and oxygen with particular reference to development sites and the risks posed by gassing sites to neighbouring land and developments. However, it is also relevant to investigations under Part 2A of the Environmental Protection Act 1990 [1] and under the Environmental Damage Regulations [2] (e.g. in respect of spills of oils, etc.).

A variety of gases might be present in the ground naturally, or as a result of contamination, or deposition of wastes. In addition to the main components found in air (nitrogen, oxygen, carbon dioxide), ground gas can contain other gases (methane, carbon monoxide, hydrogen sulfide, ammonia, helium, neon, argon, xenon, radon, etc.). It can also contain volatile organic compounds or inorganic vapours (mercury) which are of special interest in relation to the investigation of soil and groundwater contamination.

In order to complete an assessment of the risks posed by the presence of permanent and other ground gases, it is necessary to understand the potential sources of gas in and around a site. It is important to collect information on the other aspects of the site, including for example the history of the site, the natural and man-made geology of the site and surrounding areas, the hydrogeological regime, and the uses of the site and surrounding land. It is also useful to collect data on the nature of man-made soils including measurements of organic carbon content. These aspects are dealt with in BS 10175.

This information is used to develop a conceptual model of the site and surrounding area. The conceptual model is a description and/or representation of the site, incorporating what is known about the ground and groundwater conditions; the actual and potential contamination; the actual or potential presence of naturally occurring hazardous substances; the physical conditions and environmental setting; the receptors; and potential pathway linkages between contamination sources and receptors.

Development of the conceptual model requires an understanding of both the short-term (e.g. explosion or asphyxiation) and long-term hazards posed by the permanent gases and VOCs that might be present. Some relevant information is provided in Annex D of this standard.

Depending upon the objectives of the investigation, it could be relevant to consider new future receptors associated with the construction and completion of a new development, as well as existing receptors. Potential changes in the environmental setting (e.g. rising ground and surface water level) might also be relevant. The conceptual model leads to the formulation of contamination-related and other hypotheses, which the investigation process examines through the collection of relevant data.

The conceptual model is first formulated during the preliminary investigation (desk study and site reconnaissance) and informs subsequent investigations, if these are necessary, to meet the objectives of the overall investigation. One of the objectives will be reduction of uncertainty in the conceptual model. Consequently, the conceptual model is subject to regular review and updating as the work progresses.

Site investigation is an integral part of risk assessment (see CLR 11 [3]) and throughout this standard, the need for the information requirements for satisfactory risk assessment to inform the design of the site investigation programme is emphasized. However, there will be occasions where a risk assessment has been completed, and the primary purpose of the investigation is to collect additional information to aid design of protective measures, whilst of course, using the newly collected information to refine the risk assessment. Guidance is not provided on risk evaluation and characterization but guidance can be found in CIRIA C665 [4], CIRIA Report C682 [5], *Ground Gas Handbook* [6] and *Guidance on managing the risk of hazardous gases when drilling near coal* [7]. A hazard-fault/event-consequence probability analysis might be required when dealing with gas (see CIRIA report 152, *Risk assessment for methane and other gases in the ground* [8]). BS 8485, which is expected to be revised after publication of this standard (April 2013), gives recommendations and describes methods for the assessment of methane and carbon dioxide during new development of affected sites and appropriate protective measures for buildings. It does not consider ground gases other than methane and carbon dioxide. Guidance on protective measures has also been published by others (see references [9] to [13] in the Bibliography).

Carbon dioxide and methane are both powerful greenhouse gases and their uncontrolled release from landfills, etc. into the atmosphere is of concern in respect of their potential to contribute to climate change (in this sense the atmosphere is a receptor). The investigation of landfills, coal mines and other potential sources in order to design schemes for collection and/or beneficial use of gaseous emissions is outside the scope of this standard. Guidance on this has been published by the Environment Agency and others (see Bibliography for useful further reading).

The design of control measures (e.g. to prevent gas migration to adjacent land) and protective measures for buildings and other structures is outside the scope of this standard. However, when selecting such measures, it is advisable to consider the possible effects of the proposed measures on climate change in accordance with national policy.

As far as practical, the guidance on investigations for permanent gases and VOCs is provided together in an integrated text. Only where the approach required differs are they dealt with separately. It is important to consider them together rather than as separate issues because they commonly occur together. For example, petroleum hydrocarbons will degrade to form carbon dioxide under aerobic conditions and to form carbon dioxide and methane under anaerobic conditions. Indeed, the presence of carbon dioxide and/or methane is a powerful indicator that natural attenuation of hydrocarbons is taking place. Similarly, tipped wastes sometimes contain soil contaminated with VOCs and/or drums of VOCs. Radon could also be present in conjunction with other gases and VOCs.

BS 10175 advises early consultation with regulators when potentially contaminated sites are to be investigated. This advice applies equally to investigations for ground gas. Annex A describes the regulatory framework in the UK in March 2013 and the roles performed by different regulators. It is expected that Annex A of this standard will supersede BS 10175:2011, Annex I, when BS 10175 is amended to take account of the publication of this standard.

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1 Scope

This British Standard provides guidance on the monitoring and sampling of ground gases. It covers volatile organic compounds (VOCs) and permanent gases such as carbon dioxide, methane and oxygen. It is intended to be read in conjunction with BS 10175.

Guidance is not provided on:

- risk evaluation and characterization;

NOTE 1 Guidance can be found in CLR 11 [3], CIRIA C665 [4], CIRIA C682 [5] and the Ground Gas Handbook [6].

- 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 gases;
- monitoring and sampling for radon.

NOTE 2 Radon occurs naturally at varying concentrations in large parts of the United Kingdom. It is commonly present in mine gas and can also be released from groundwater when it is extracted from the ground. It can also arise from deposited wastes such as those from the nuclear industry, phosphorus slags, and coal ash. Its importance lies in the fact that the risks associated with exposure to it are serious and its effects on the human condition are backed by extensive epidemiological information. There are established or draft International Standards for investigation and determination of radon in soils (BS ISO 18589 series) and in air (BS ISO 11665-1). The latter provides guidance on analysis of historic records, site reconnaissance, identification of preferential migration pathways, development of a sampling plan and how to measure radon in air once it has been emitted from the ground (see Annex B for further information). At the time of publication of this standard, the committee are not aware of any international standards or other authoritative guidance on the measurement and sampling of radon in the ground analogous to that provided in this standard for permanent gases and VOCs. The state-of-the-art is not sufficiently developed in the UK to provide such guidance as part of this standard but some preliminary guidance is provided for information in Annex B.

*NOTE 3 The term "permanent gas" (**3.10**) is used rather than "bulk gas" as used in much UK guidance. The two are not synonyms. "Permanent gas" is an accepted international term in use for over 100 years. Its usage does not indicate any relationship between the proportion of a gas present and its properties in the way that the terms "bulk gas" and "trace gas" do. These terms were originally used in connection with "landfill gas". "Permanent gas" is considered more appropriate for the range of sources covered by this standard.*

NOTE 4 "Ground gas" has the same meaning as "soil gas" as defined in BS ISO 11074, i.e. "gas and vapours in the pore spaces of soils".

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5930, *Code of practice for site investigations*

BS 10175, *Investigation of potentially contaminated sites – Code of Practice* [1)]

[1)] BS 10175:2011 is also referenced in this standard informatively.