

BRITISH STANDARD

Code of practice for the characterization and remediation from ground gas in affected developments

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 October 2007. It was prepared by Technical Committee I/-/2, *Brownfield developments*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

This standard was developed to provide designers of developments on sites affected by ground gas with a structured method for risk-based solution choice.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its 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

When building/developing on or adjacent to: brownfield sites, sites where degradable materials are present within the ground, and in areas of mineworkings, there is a potential risk of the generation of ground gases and accumulation of these gases within buildings. Under adverse circumstances, methane and carbon dioxide gases can build up to hazardous concentrations within confined spaces giving rise to a potential risk of explosion or asphyxiation. Indeed, there are documented cases of loss of life and damage to property resulting from ground gas accumulation.

Guidance available up to the date of this British Standard has generally focused on the occurrence and methods of measurement of ground gases and the incorporation of protection measures into buildings to mitigate the risk of building on sites affected by ground gas. The issue of how to undertake assessment of gas monitoring data in order to determine suitable parameters to be used in the design of protection measures has, until recently, not been developed to any significant degree and, as a result, design solutions often lack a rigorous assessment of data and have often resulted in overly conservative solutions or insufficient measures being adopted.

This standard is intended to provide a framework in line with CLR 11 [1] that will allow designers to judge the adequacy of ground gas and related site investigation data, and provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions that will mitigate against the presence of ground gas on a development site. Importantly, it allows the identification of those sites where gas protection measures are not required. The framework is not prescriptive and judgement may be made as to the acceptability of risk and whether there is a cost benefit in undertaking more rigorous site assessment or adopting conservative measures in design. Emphasis is placed on the justification and recording of risk assessments and design decisions throughout the process.

This standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. It recognizes that there are a number of factors requiring consideration which affect the sensitivity of the development to the effects of ground gas, and that there are a range of solutions available for different situations. In this regard it is anticipated that specialist advice will be required in the assessment of the ground gas data and in the risk assessment phase.

1 Scope

This British Standard gives recommendations and describes methods for the investigation and assessment of the ground gases methane and carbon dioxide during new development of affected sites, and is not intended for the assessment of completed developments.

It details a process that can be used to effectively demonstrate that risks posed by the potential presence of ground gas have been adequately considered and addressed.

It presents the assessment and decision making stages in the form of a process flowchart, accompanying information and explanatory guidance and, where appropriate, references to other guidance and information.

The standard does not consider ground gases other than methane and carbon dioxide.

NOTE Other gases might require specific risk assessments and have to be considered separately.

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.

BS 10175:2001, *Investigation of potentially contaminated sites – Code of practice*

Card G, Hutchings H, Mallett H, Oliver S, Wilson S. CIRIA C665, *Assessing risks posed by hazardous ground gases for buildings*. CIRIA. 2007. (Formerly issued as C659.)

BRE Report 414. Johnson R. *Protective measures for housing on gas contaminated land*. 2001.

3 Terms and definitions

For the purposes of this document the terms and definitions in CLR 11 [1] and the following apply.

NOTE These terms are not to be confused with similar terms in other referenced documents.

3.1 ground gas

potentially hazardous gas, generated below ground

NOTE The most common ground gases are methane and carbon dioxide.

3.2 measured flow rate

q

total gas flow from a borehole measured in volume per unit time (typically litres per hour)

3.3 measured hazardous gas concentration

C_{hg}

concentration of a specific hazardous gas measured as a percentage of the total gas volume from a borehole

3.4 calculated hazardous gas flow rate

Q_{hg}

calculated flow rate of a specific hazardous gas from a borehole reading, i.e.

$$Q_{hg} = \frac{C_{hg}}{100} q$$

3.5 site characteristic hazardous gas flow rate

Q_{hgs}

flow rate representative of a site or zone, derived from empirical borehole data and other influencing factors, in accordance with a conceptual model

NOTE 1 This figure is derived using professional judgement.

NOTE 2 Also known as “gas screening value”, e.g. in CIRIA C665.

4 Overview of ground gas characterization and assessment

The process of assessing the appropriate treatment of ground gas in an affected site should follow the flowchart in Figure 1.

5 Site categorization

5.1 Desk Study

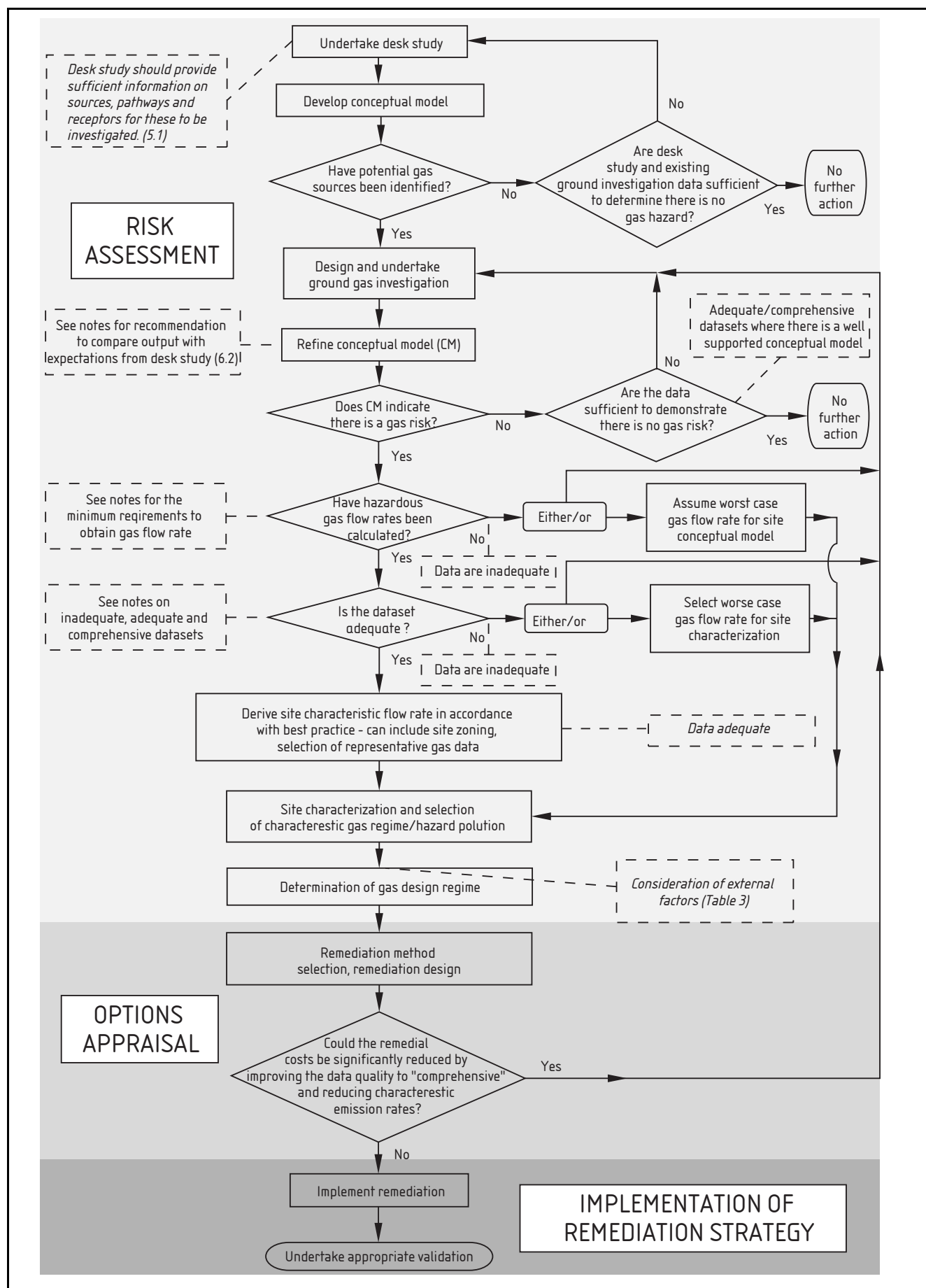
COMMENTARY ON 5.1

The main objectives of the desk study are to start the process of constructing a conceptual model of the likely gas sources on or near the site, the likely migration pathways and receptors. This will inform further site investigation which will in turn revise and augment the conceptual model. Relevant guidance on the requirements and objectives of a desk study can be found in BS 10175:2001. Site investigations ought to be designed in accordance with BS 5930 and published guidance such as the AGS Guidelines for Good Practice in Site Investigation [2]. Detailed advice on investigation of ground gas can be found in CIRIA C665.

The primary requirements and objectives of the desk study should all be met, which are as follows.

- a) Have all potential gas sources been identified or discounted? The assessment should include identification of natural geological sources, mine workings, waste materials, landfills, and an understanding of the nature of the gas generation processes involved.
- b) Have the site history and current use been evaluated and any likely gas sources, migration pathways and receptors arising from site uses been identified?
- c) Is there a clear understanding of the geology and hydrogeology of the site, and the presence of contamination, and how it might affect gas sources and gas migration? This includes the effect of groundwater level variations, including tidal variations (and how these can affect gas sources and gas migration).
- d) Have all potential pathways been identified or discounted? This includes natural geological pathways, services, underground structures and mine workings.
- e) Have potential receptors, both on and off site, been identified and their sensitivity assessed?

Figure 1 Ground gas characterization and assessment flowchart



5.2 Walk over (reconnaissance)

The desk study should be supplemented with a site walk-over study as recommended in BS 10175:2001, **6.2.2**.

5.3 Site investigation

Data derived from the main site investigation should be used to assess the risk of gassing and to design remediation measures. The key elements of the site investigation should be as follows.

- a) The investigation should be designed to confirm the geology and hydrogeology of the site, the presence of made ground, contamination, identification of the source and the nature of the mechanism of gas generation, from borehole/trial pit logs, and where appropriate sampling, testing and analysis.
- b) Where appropriate, the use of geophysical/remote sensing techniques should be used to help delineate the extent of landfill or made ground and the location of the methanogenic material.
- c) Monitoring installations: are the type and depth of monitoring installations adequate to identify gas sources and migration pathways, and to determine whether receptors are likely to be impacted?
- d) Distribution of monitoring points: are monitoring locations distributed such that sources, migration pathways and receptors can be adequately characterized?
- e) Monitoring instrumentation: are the instruments used to monitor gas appropriate and properly maintained, calibrated and operated?
- f) Monitoring parameters: is enough information regarding gas composition, concentrations and flows available to characterize risk, and are there sufficient data concerning the factors that affect gas migration and emission to assess the likely variability of the gas regime? Are the data accurately measured and reported?
- g) Monitoring frequency: is the frequency of monitoring sufficient to characterize the consistency or inconsistency of the gas regime over the monitoring period (see **5.4**)?
- h) Monitoring period: is the period of monitoring long enough to monitor changes in ambient conditions that influence gas generation and migration (see **5.4**)?

NOTE In-depth information about site investigation methods and considerations are given in many places (some of which are listed in the Bibliography) and particularly in CIRIA C665 and NHBC Report no.: 10627-R01 (04) [3].

5.4 Minimum requirements to assess site characteristic hazardous gas flow rate

The minimum requirements in order to assess the site characteristic hazardous gas flow rate are measured flow rates and hazardous gas concentrations from an appropriate number of monitoring locations over an appropriate number of monitoring rounds, which should include measurements taken during conditions of falling atmospheric pressure.