Revision to BS8485:2007
EPUK Consultation Workshop on Draft for Public Consultation

March 16, 2015

Part 1: Overview of the Proposed Changes

Richard Owen - ARUP
Objectives of today

• Draft for Public Consultation of BS8485:2015 (update of 2007).

• 2 months consultation period March 1\textsuperscript{st} to 30\textsuperscript{th} April.

• Today’s objectives:
  - to inform EPUK members (short cut to content);
  - to obtain and encourage feedback on the DPC;
  - a forum for questions.

• BSI timetable is publication is summer 2015
What is BS8485:2007?

- Code of practice (recommendations of what “should” be done).

- Guidance on:
  - site characterization for ground gases (methane and CO₂);
  - interpretation of gas monitoring data to derive site GSV;
  - definition of site gas regime (characteristic situation – CS);
  - empirical scoring system for gas protection measures;
  - selection of gas protection measures for new developments.

- ‘Slim standard’
  - 12 pages of guidance (“normative” text); and
  - 7 pages of “informative” information in 2 annexes.
5 Year Review of BS8485:2007

- Responsibility of EH4 Soil Quality committee.
- Options:
  - retain unchanged;
  - withdraw; or
  - revise.
- Limited consultation Oct 2012
- Revision recommended.
- Business case approved – April 2013.
- Drafting panel established.
Brief for revision

• Scope of Standard to remain essentially unchanged.
• Revise to reference and reflect BS’s and industry good practice guidance published since its 2007 publication.
• Clearer guidance on interpretation of gas monitoring data and assignment of CS.
• Reference Technical Note RB17 CS classification using TOC.
• Review and expand guidance on protection measures scoring (old Table 3).
• Include reporting requirements.
• Add annexes on radon and VOCs.
## Drafting Panel

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Representing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richard Owen - chairman</td>
<td>Arup</td>
<td>EH4 (Inst. Civil Engineers)</td>
</tr>
<tr>
<td>Mike Smith</td>
<td>Private consultant</td>
<td>EH4 (Society Chem. Industries)</td>
</tr>
<tr>
<td>Steve Wilson</td>
<td>EPG</td>
<td>Co-opted – Industry expert</td>
</tr>
<tr>
<td>Karen Thornton</td>
<td>NHBC</td>
<td>Co-opted – NHBC</td>
</tr>
<tr>
<td>Peter Atchison</td>
<td>PA Geotechnical Ltd</td>
<td>Chair of BS8485:2007 panel</td>
</tr>
<tr>
<td>Seamus Lefroy-Brooks</td>
<td>LBH Wembley</td>
<td>Co-opted – BGS</td>
</tr>
<tr>
<td>George Flower</td>
<td>Hyder Consulting</td>
<td>Member of BS8485:2007 panel</td>
</tr>
<tr>
<td>Bill Baker</td>
<td>Private consultant</td>
<td>EH4 (CIEH)</td>
</tr>
<tr>
<td>Gavin Jones</td>
<td>BSI content developer</td>
<td>BSI</td>
</tr>
</tbody>
</table>
Main Changes (1)

- New title.
- Structure the same, content re-written/expanded (now 80 pages).
- New flow charts to guide the user.
- Desk study and ground investigation guidance now xref BS8576.
- More detailed guidance on interpretation of gas monitoring data.
- Informative guidance on approach for CS characterization without gas monitoring data for Made Ground source (after CL:AIRE RB17) in Annexes D and E.
Main Changes (2)

- Changes to Table 2 (now Table 3) – required gas protection score and definition of Building Types A to D.
- Substantial changes to Table 3 (now Tables 4a, 4b and 4c) – gas protection scores for different types of protection measures.
- Definition of “gas resistant membrane” and only membrane meeting all material performance and installation requirements (in Table 4c) will score ‘protection points’. (Nil for others)
- Recommendation for reporting of design and installation.
- Rewritten and expanded annexes supporting Tables 4a, 4b, 4c.
- New annexes: Worked Examples (F), Radon (G), VOCs (H).
Change of Title

- BS8485:2007
  Code of practice for the characterization and remediation from ground gas in affected developments

- BS8485:2015 – DPC
  Code of practice for the design of protective measures for methane and carbon dioxide ground gases in new building developments
Worked Examples (Annex F)

• Site A: Made Ground and Alluvium ground gas sources.
• Site B: 1960s landfill in former gravel pit.
• Evaluation of gas monitoring data, including approach to deficiencies in standpipe installation, evaluation of peak and steady state flows and concentrations, and assignment of GSV (and associated CS).
• Consideration of different types of building on Site A and Site B and options for protective measures to achieve minimum ‘score’ required by Table 3 for each type of building.
Part 2: Methods of Gas Regime Characterization
(Section 6)

Richard Owen - ARUP
Methodologies for ground gas characterization (6.2)

- Detailed quantitative approach (6.2.1 and 6.4).
- Empirical semi-quantitative approach using gas monitoring data (6.2.2 and 6.3).
Characterization using gas monitoring data (6.3)

- Gas Screening Value (GSV) for the site (or each zone of the site) is interpreted from the gas monitoring measurements and is then used to assign the CS for the site (or zone of the site).
- Zoning of sites.
- Calculation of $Q_{hg\text{ methane}}$ and $Q_{hg\text{ carbon dioxide}}$ for each mon. event.
- Reviewing the database for sufficiency/adequacy – discounting unrepresentative measurements and/or installations.
- Combining monitoring data if dataset is not considered comprehensive (spatially, temporally).
- Peak and steady state flows and concentrations.
- Review of negative flows (in-flows) – plausible outflow, or not?
- Worst case check.
Revision to CS designation Table

<table>
<thead>
<tr>
<th>Characteristic gas situation</th>
<th>Hazard potential</th>
<th>GSVA</th>
<th>Additional factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>&lt;0.07</td>
<td></td>
<td>Typically &lt;1% methane concentration and &lt;5% carbon dioxide concentration (otherwise consider an increase to CS2)</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;0.07, &lt;0.7</td>
<td></td>
<td>Typical measured flow rate &lt; 70 l/h (otherwise consider an increased characteristic gas regime)</td>
</tr>
</tbody>
</table>

| Moderate                    | >0.7, <3.5       |      |                      |
| Moderate to high            | >3.5, <15        |      |                      |
| High                        | >15, <70         |      |                      |
| Very high                   | >70              |      |                      |

NOTE The side characteristic hazardous gas flow rate is synonymous with the “gas screening value” in CIRIA C665 and NHBC Report no.: 10627-R01 (04) [3].

Table 2 – CS by site characteristic GSV

<table>
<thead>
<tr>
<th>CS</th>
<th>Hazard potential</th>
<th>Site characteristic GSV(^{a})</th>
<th>Additional factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS1</td>
<td>Very low</td>
<td>&lt;0.07</td>
<td>Typically &lt;1 % methane concentration and &lt;5 % carbon dioxide concentration (otherwise consider an increase to CS2)</td>
</tr>
<tr>
<td>CS2</td>
<td>Low</td>
<td>0.07 to &lt;0.7</td>
<td>Typical measured flow rate &lt;70 L/hr (otherwise consider an increase to CS3)</td>
</tr>
<tr>
<td>CS3</td>
<td>Moderate</td>
<td>0.7 to &lt;3.5</td>
<td>–</td>
</tr>
<tr>
<td>CS4</td>
<td>Moderate to high</td>
<td>3.5 to &lt;15</td>
<td>–</td>
</tr>
<tr>
<td>CS5</td>
<td>High</td>
<td>15 to &lt;70</td>
<td>–</td>
</tr>
<tr>
<td>CS6</td>
<td>Very high</td>
<td>70</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^{a}\) The figures used in this column are empirical.

NOTE The CS is equivalent to the characteristic gas screening value in CIRIA C665 [8].
A Pragmatic Approach to Ground Gas Risk Assessment

Sarah Mortimer
Environmental Protection Group
Introduction

- CL:AIRE Research Bulletin 17 (RB17), Published November 2012.
- A new approach to ground gas risk assessment that removes the need for gas monitoring on many low risk sites.
Drivers for Approach

• Experience from low risk sites shows relying on gas monitoring results alone can be misleading.
• Leads to disagreements and delays in planning.
• Do we need to monitor on low risk sites?
• Do we need to monitor where gas protection is to be provided anyway?
• Recognise limitations of gas monitoring and value of multiple lines of evidence.
New Approach

- Considers source(s) of gas – informed by a robust Conceptual Site Model.

- Defines if a source is low or high risk. Assessment of risk is based on how much gas is likely to be generated. Limiting Values are defined by the framework, which are based on gas generation modelling.

- If high risk then gas monitoring is required consistent with C665 and BS8485.

- If it is a low risk site then there are two exist points within the framework;
  1. Gas monitoring is not required and gas protection measures are not required.
  2. Gas monitoring is not required but gas protection measures are required. Scope of gas protection measures to be determined based on TOC content of source.

- Aims to ensure risks are managed in a consistent, robust and appropriate manner – utilising multiple lines of evidence.
Lines of Evidence

• Robust desk study is vital, including graphical representation of Conceptual Site Mode.

• Site investigation to allow good visual assessment of source – trial pits are best.

• Need to consider heterogeneity of MG. Forensic descriptions of MG (10-15kg bulk sample) to adequately characterise the material.

• TOC tests on fine soil fraction.
Comprehensive site investigation in accordance with Table 2

Preliminary investigation

Ground Investigation
- Site investigation should include trial pits that extend beyond any Made Ground. Where possible, avoid use of small diameter window sampling tools. Various sized boreholes/drillings may be required by the conceptual model.
- Organic carbon from leachate:
  - Optional - Cellulose, hexamethylenetramine and lignin content of directly degradable fraction (eg wood, cloth, paper, vegetable matter, etc.) was on ignition.

Forensic description is the detailed quantitative assessment of the organic carbon of soil by sorting and weighing - See Appendix A

Use data above to develop Conceptual Site Model

Consider whether credible pathways are present if offsite sources of gas are present. A credible pathway is one that is likely to be present on a particular site, considering distance to the site, the specific ground conditions and topography.

Max any of the following been identified:

Credible sources and pathways for landfill gas migration from an off-site landfill or mine workings. Whether a pathway is credible depends on distance, topography, nature of landfill (eg lining), or workings and geology. This must be demonstrated by a robust conceptual model.

Site has been a registered landfill site. (This does not include general Made Ground with occasional objects such as pieces of wood or refuse mine openings nearby)

Made Ground max depth > 5m or average depth > 3m?

Representative TOC results from Made Ground exceed maximum values for CS3 given in Table 2.

Gas monitoring required and assessment in accordance with CIRIA C6165 and BS 8485: 2007.

Are only natural soils present that do not produce methane and can only produce carbon dioxide. This is not considered a significant ground gas source (eg chalk, Glacial Till).

Yes

Site is defined as CS1

Gas monitoring not required.

Construction without any gas protection

No

Are radon protection measures required?

Yes

Gas monitoring not required.

Provide radon protection measures

No

IfYes

Are radon protection measures required?

Yes

Gas monitoring not required. Provide radon protection measures

No

Gas monitoring not required.

Provide radon protection measures

Where natural sources of gas such as Alluvium, peat are present provide CS2 gas protection measures.

Gas protection where Made Ground is present > 1m defined using a site-specific assessment and the limiting values of TOC in Table 1.

For CS1 the minimum standard of floor slab construction should meet the air tightness requirements in NHBC guidance - "A practical guide to building all tight doors", ie all damp proof membranes need to be sealed.

Ventilated undercroft etc to give very good ventilation in accordance with BS 8485: 2007 and gas-tight resistant membranes, venting to achieve very good ventilation. Independent verification of membrane and venting installation required.

See Note 4.
## Comprehensive site investigation in accordance with Table 2

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground investigation</td>
<td>Site investigation should include trial pits that extend beyond any Made Ground where possible. Avoid use of small diameter window samplers unless it can be justified by reference to conceptual model. Forensic description of soil required (i.e., sorting and weighing of different fractions)</td>
</tr>
<tr>
<td>Laboratory testing</td>
<td>Total organic carbon content (WAC testing method, Environment Agency, 2005) Dissolved organic carbon from leachate Optional - Cellulose, hemi cellulose and lignin content of clearly degradable fraction (e.g., wood, cloth, paper, vegetable matter, etc.), loss on ignition.</td>
</tr>
</tbody>
</table>

Forensic description is the detailed quantitative assessment of the organic content of soil by sorting and weighing - See Appendix A
Use data above to develop Conceptual Site Model.
Consider whether credible pathways are present if offsite sources of gas are present. A credible pathway is one that is likely to be present on a particular site, considering distance to the site, the specific ground conditions and topography. It is not a generic list of possible pathways. Consider whether effects such as rising groundwater could force large volumes of gas from the ground in a short period.

Has any of the following been identified:

- Credible sources and pathways for landfill gas migration from an offsite landfill or mine workings
- Weather a pathway is credible depends on distance, topography, nature of landfill (eg lining) or workings and geology. This must be demonstrated by a robust conceptual model.
- Site has been a registered landfill site (This does not include general Made Ground with occasional objects such as pieces of wood) or are there mine openings nearby.
- Made Ground max depth > 5m or average depth > 3m?

Representative TOC results from Made Ground exceed maximum values for CS3 given in Table 2.

- Yes
  - Gas monitoring required and assessment in accordance with CIRIA CS65 and BS 8485: 2007

- No
  - Site is defined as CS1
  - Gas monitoring not required
  - Construction without any gas protection

Are only natural soils present that do not produce methane and can only produce carbon dioxide. This is not considered a significant ground gas source (eg chalk, Glacial Till).

- Yes
  - Provide radon protection measures
- No
  - Are radon protection measures required?
    - Yes
      - Provide radon protection measures
    - No
      - Gas monitoring not required

Are radon protection measures required?

- Yes
  - Gas monitoring not required
  - Provide radon protection measures
- No
  - Gas monitoring not required

Where natural sources of gas such as Alluvium, peat, etc are present provide CS2 gas protection measures

Gas protection where Made Ground is present >1m defined using a site specific assessment and the limiting values of TOC in Table 1.

For CS1 the minimum standard of floor slab construction should meet the air tightness requirements in NHBC guidance - “A practical guide to building air tight dwellings”, ie all damp proof membranes needed to be sealed.

Ventilated underfloor void to give very good venting in accordance with BS 8485: 2007 and gas/resistant membrane, venting to achieve very good ventilation. Independent verification of membrane and venting installation required.
Three Exit Points from Flow Chart

• Gas monitoring is not necessary and gas protection measures are not required.

• Gas monitoring is not necessary but gas protection measures are required – determine scope using TOC content of source.

• Gas monitoring is required to further inform assessment of risk.
<table>
<thead>
<tr>
<th>Characteristic situation (BS 8485 and CIRIA C665)</th>
<th>Depth of Made-Ground (m)</th>
<th>Maximum total organic carbon content of Made-Ground - TOC (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>New Made-Ground in place for ≥ 20 years</td>
<td></td>
</tr>
<tr>
<td>CS1</td>
<td>Maximum 5m</td>
<td>≤1.0</td>
<td>Limiting values based on reported soil organic matter (SOM) content of natural soils up to about 1%</td>
</tr>
<tr>
<td></td>
<td>Average &lt;3m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS2</td>
<td>Maximum 5m</td>
<td>≤1.5</td>
<td>Limiting values based on gas generation-modelling assuming slow degradation</td>
</tr>
<tr>
<td></td>
<td>Average &lt;3m</td>
<td>≤3</td>
<td>Equilibrium methane concentration in building above 0.01%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS3</td>
<td>Maximum 5m</td>
<td>≤4</td>
<td>Limiting values based on gas generation-modelling assuming slow degradation</td>
</tr>
<tr>
<td></td>
<td>Average &lt;3m</td>
<td>≤6</td>
<td>Equilibrium methane concentration in building above 0.01%</td>
</tr>
</tbody>
</table>

This method can only be used to define characteristic situations up to 3 m. Gas monitoring required where TOC is greater than 6%. Gas monitoring results will show whether the high TOC is available and conditions are suitable to generate ground gas.

Note 1: \( \text{TOC} = \text{DOC} \times 1.33 \) (Hesse, 1971)

Note 2: TOC tested in accordance with the method described in Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures, (Environment Agency, 2005)
Theory to Practice

- The method has been used successfully on a number of sites.
- Used to resolve disputes over classification of site based on gas monitoring data.
- Used where majority of source being removed so gas data irrelevant.
- Saved time and money by avoiding need to collect more gas data.
- Provides an additional line of evidence for site assessment.
<table>
<thead>
<tr>
<th>Scenario and source of ground gas</th>
<th>Gas monitoring?</th>
<th>Gas protection?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural soils with no Made Ground, Eg London Clay, Mercia Mudstone, Lias Clay, Chalk, Gault Clay, Glacial Till</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Natural soils with No Made Ground – in an area where radon protection is required.</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Natural soils with low organic content – less than 1m of Made Ground that comprises general infill and car park construction materials. Eg Made Ground over London Clay, Mercia Mudstone, Lias Clay, Chalk, Gault Clay or Glacial Till</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Natural soils with high organic content and less than 1m of Made Ground that comprises general infill and car park construction. Eg Alluvium, Peat over natural soils such as London Clay, Mercia Mudstone, Lias Clay, Chalk, Gault Clay or Glacial Till</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Natural soils with low organic content and 1m to 5m of Made Ground that comprises general infill and car park construction materials TOC less than 6%. Eg Made Ground over London Clay, Mercia Mudstone, Lias Clay, Chalk, Gault Clay or Glacial Till</td>
<td>✗</td>
<td>?</td>
</tr>
<tr>
<td>Old landfill with 6m of older refuse material, identified as old landfill on historical maps</td>
<td>✓</td>
<td>?</td>
</tr>
<tr>
<td>Determine gas monitoring data</td>
<td>To be determined from gas monitoring data</td>
<td></td>
</tr>
<tr>
<td>Old mineworkings that were abandoned before the early 20th Century</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Glacial Drift deposits over Coal Measures strata with no former mine workings.</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
Thank You

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Revision to BS8485:2007
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March 16, 2015

Part 4: Building Type characterization and Solution Scores (Section 7)

Richard Owen - ARUP
Solutions scores flow chart (Figure 5)

1. Characteristic gas situation (CGR) for the site or zone has been assigned.

2. Using Table 6, determine the gas protection score required for the type of building (Type A to Type E).

   - Option selection is illustrated in Appendix F (Worked Examples).
   - Consider the options of how the score might be achieved by combining two or more protection elements using Table 4 (A to E).

3. Detailed design and specification of each protection element to confirm their score (to be documented in design report).

   - Could protection score be significantly reduced by improving confidence in the site investigation data?
     - Yes → Go to implementation.
     - No → Proceed further site investigations (Clause 8).

   - Could protection score be significantly reduced by undertaking more modelling and risk assessments of the gas regime, pathways, and sources?
     - Yes → Carry out more detailed modelling and risk assessments.
     - No → Prepare design report.

   - Prepare design report.

ARUP
## Required Scores and Building Types, BS8485:2007

### Table 2 Required gas protection by characteristic gas situation and type of building

<table>
<thead>
<tr>
<th>Characteristic gas situation, CS</th>
<th>NHBC traffic light</th>
<th>Required gas protection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Non-managed property, e.g. private housing</td>
<td>Public building</td>
</tr>
<tr>
<td>1</td>
<td>Green</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Amber 1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Amber 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Red</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

**NOTE** Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

**A)** Public buildings include, for example, managed apartments, schools and hospitals.

**B)** Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.

**C)** Maximum methane concentration 20% otherwise consider an increase to CS3.

**D)** Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

**E)** Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.
Firstly, the construction and use of the building, together with the control of future structural changes to the building and its maintenance (the building’s management) should be assessed, since potential risks posed by ground gases are strongly influenced by these factors. The assessment should lead to the categorization of the building as a whole, or each different part of the building, into one of four building types (Type A, Type B, Type C or Type D).

The typical characteristics of each building type and example uses that should be used for the categorization are described below; **Type A buildings** are those where the risk of failure of the gas protection measures is greatest and **Type D buildings** are those where this same risk is least:

<table>
<thead>
<tr>
<th>Building Type:</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>Private</td>
<td>Private or commercial/public, possible multiple</td>
<td>Commercial/public</td>
<td>Commercial/industrial</td>
</tr>
<tr>
<td>Control (change of use, structural alterations, ventilation)</td>
<td>None</td>
<td>Some but not all.</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Room sizes</td>
<td>Small</td>
<td>Small/medium</td>
<td>Small to large</td>
<td>Large industrial/retail park style</td>
</tr>
<tr>
<td>Building or civil engineering construction</td>
<td>Building</td>
<td>Building/Civil</td>
<td>Civil</td>
<td>Civil</td>
</tr>
</tbody>
</table>
From the design CS and the type of building (A, B, C or D) the minimum level of gas protection (score) in the range 0 to 7.5 should be obtained from Table 3.

### Table 3 – Required gas protection score by CS and type of building

<table>
<thead>
<tr>
<th>CS</th>
<th>Type A building</th>
<th>Type B building</th>
<th>Type C building</th>
<th>Type D building</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3.5</td>
<td>3.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>4.5</td>
<td>4</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>4</td>
<td>6.5&lt;sup&gt;B)&lt;/sup&gt;</td>
<td>5.5&lt;sup&gt;B)&lt;/sup&gt;</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>5</td>
<td>&lt;sup&gt;C)&lt;/sup&gt;</td>
<td>6.5</td>
<td>5.5</td>
<td>4.5</td>
</tr>
<tr>
<td>6</td>
<td>&lt;sup&gt;C)&lt;/sup&gt;</td>
<td>&lt;sup&gt;C)&lt;/sup&gt;</td>
<td>7.5</td>
<td>6.5</td>
</tr>
</tbody>
</table>

<sup>A)</sup> If parts of the building have the characteristics of a building type with higher risk, then those parts of the building should have protection meeting the minimum score for that higher risk type.

<sup>B)</sup> Residential buildings should not be built on CS4 sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

<sup>C)</sup> The gas hazard is too high for this empirical method to be used to define the gas protection measures.
Comparison of Table 2 (2007) and Table 3 (2015)

Table 3 – Required gas protection score by CS and type of building

<table>
<thead>
<tr>
<th>CS</th>
<th>Required minimum gas protection score (points)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Risk ........................................Medium Risk ..................................Low Risk</td>
</tr>
<tr>
<td></td>
<td>Type A building</td>
</tr>
<tr>
<td></td>
<td>Non-managed property e.g. private housing</td>
</tr>
<tr>
<td>1</td>
<td>0 0</td>
</tr>
<tr>
<td>2</td>
<td>3.5 3</td>
</tr>
<tr>
<td>3</td>
<td>4.5 4</td>
</tr>
<tr>
<td>4</td>
<td>6.5B) 6</td>
</tr>
<tr>
<td>5</td>
<td>– C)</td>
</tr>
<tr>
<td>6</td>
<td>– C)</td>
</tr>
</tbody>
</table>

A) If parts of the building have the characteristics of a building type with higher risk, then those parts of the building should have protection meeting the minimum score for that higher risk type.

B) Residential buildings should not be built on CS4 sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

C) The gas hazard is too high for this empirical method to be used to define the gas protection measures.
Solution Scores (Table 3 BS8485:2007)

<table>
<thead>
<tr>
<th>PROTECTION ELEMENT/SYSTEM</th>
<th>SCORE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Venting/dilution (see Annex A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)</td>
<td>2.5</td>
<td>Good performance in accordance with Annex A. If passive ventilation is poor this is generally unacceptable and some form of active system will be required.</td>
</tr>
<tr>
<td>Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)</td>
<td>2.5</td>
<td>There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: exhaustion and positive pressurization. Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F [5] and Non-E guidance [6].</td>
</tr>
<tr>
<td>Ventilated car park (basement or undercroft)</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

b) Barriers
- Block and beam floor slab | 0     |          |
- Reinforced concrete ground bearing floor slab | 0.5   | It is good practice to install ventilations in all foundation systems to effect pressure relief as a minimum. |
- Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab | 1.5   | Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances. |
- Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints | 1.5   |          |
- Fully tanked basement | 2     |          |

c) Membranes
- Taped and sealed membrane to reasonable levels of workmanship in line with current good practice with validation $^a$, $^b$ | 0.5   | The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints. |
- Proprietary gas resistant membrane to reasonable levels of workmanship in line with current good practice under independent inspection (CQA) $^b$, $^c$ | 1     |          |
- Proprietary gas resistant membrane installed to reasonable levels of workmanship in line with current good practice under CQA with integrity testing and independent validation | 2     |          |

d) Monitoring and detection (not applicable to non-managed property, or in isolation)
- Intermittent monitoring using hand held equipment | 0.5   | Where fitted, permanent monitoring systems ought to be installed in the underfloor ventilation/dilution system in the first instance but can also be provided within the occupied space as a fail safe. |
- Permanent monitoring and alarm system $^a$ | 2     |          |

NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection.

2015 DPC Revisions

Venting/Dilution now Table 4b and Annex B (normative)

Structural barrier now Table 4a and Annex A (informative)

Membrane now Table 4c and Annex C (informative)

No scores for monitoring and dilution
### 7.2.1 Structural barrier

The first step in the methodology should be assessment of the gas protection score of the structural barrier, since the construction of the floor slab has usually already been decided at the time the gas protection measures are being designed.

*NOTE* The floor slab design, and any basement design, are usually determined by geotechnical and constructability factors.

The common types of floor slab and substructure design and their relative performance as a structural barrier to ground gas ingress are described in Annex A. The guidance in Annex A should be used together with Table 4a to assign the structural barrier score.

**Table 4a – Gas protection scores for the structural barrier**

<table>
<thead>
<tr>
<th>Floor and substructure design (see Annex A)</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>precast suspended segmental subfloor (i.e. beam and block)</td>
<td>0</td>
<td>Breaches in floor slabs, such as joints and service entries, should be effectively sealed against gas ingress to maintain these performances.</td>
</tr>
<tr>
<td>cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended with minimal penetrations</td>
<td>1 or 1.5(^{A)})</td>
<td></td>
</tr>
<tr>
<td>Basement floor and walls in accordance with BS 8102:2009, Grade 2 waterproofing</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Basement floor and walls in accordance with BS 8102:2009, Grade 3 waterproofing</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

\(^{A)}\) To achieve a score of 1.5 there should be a semi-raft slab with minimal penetrations cast in (see A.2.1.2).
## Solutions for Worked Examples (Annex F)

### Table F.8 – Combinations of measures to provide a gas protection solution for different types of building at Site A

<table>
<thead>
<tr>
<th>Type and use of building</th>
<th>Required minimum score</th>
<th>Structural Barrier score</th>
<th>Ventilation/dilution score</th>
<th>Gas membrane score</th>
<th>Total achieved score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional residential house (no basement) (Building Type A)</td>
<td>3.5</td>
<td>Suspended beam and block (1)</td>
<td>Ventilated (2)</td>
<td>Gas resistant membrane (3)</td>
<td>3.5 (fail)</td>
</tr>
<tr>
<td>School and/or hospital, at grade A (partly Building Type B and partly Building Type C)</td>
<td>3.5 (part) and 2.5 (part)</td>
<td>Cast in-situ suspended slab (1)</td>
<td>Low-free gas barrier slab (2)</td>
<td>Gas resistant membrane (3)</td>
<td>3.5</td>
</tr>
<tr>
<td>Basement area of office building (partly basement)</td>
<td>2.5</td>
<td>Cast in-situ suspended slab (1)</td>
<td>Poorly ventilated basement car park (2)</td>
<td>Gas resistant membrane (3)</td>
<td>2.5</td>
</tr>
<tr>
<td>Office building with basement plant rooms (Building Type C)</td>
<td>3.5</td>
<td>BS8102 grade 3 waterproofed basement (1)</td>
<td>No external ventilation measures (2)</td>
<td>Gas resistant membrane (3)</td>
<td>3.5 (fail)</td>
</tr>
<tr>
<td>Large floor plan retail commercial Industrial building (no basement) (Building Type D)</td>
<td>1.5</td>
<td>Suspended floor slab (1)</td>
<td>6F2 sub-base + geo-composite gas dispersal layer (2)</td>
<td>Low voltage polyethylene void former layer and low level side vents (3)</td>
<td>1.5</td>
</tr>
</tbody>
</table>

A) The combinations of measures given in Table F.8 are examples of how the minimum required score could be achieved. Other combinations of measures might be more appropriate for a particular building.

### Table F.14 – Combinations of measures to provide a gas protection solution for different types of building at Site B

<table>
<thead>
<tr>
<th>Type and use of building</th>
<th>Required minimum score</th>
<th>Structural Barrier score</th>
<th>Ventilation/dilution score</th>
<th>Gas Membrane score</th>
<th>Total achieved score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional residential house, at grade A (Building Type A)</td>
<td>4.5</td>
<td>Suspended beam and block (0)</td>
<td>High voltage polyethylene void former layer (1)</td>
<td>Gas resistant membrane (2)</td>
<td>4.5</td>
</tr>
<tr>
<td>School and/or hospital, at grade A (partly Building Type B and partly Building Type C)</td>
<td>4 (part) and 3 (part)</td>
<td>Cast in-situ ground-bearing slab (1)</td>
<td>No effective ventilation measures (2)</td>
<td>Gas resistant membrane (3)</td>
<td>4 (pass)</td>
</tr>
<tr>
<td>Managed apartments, at grade A (Building Type D)</td>
<td>4</td>
<td>Cast in-situ r/f suspended slab (1.5)</td>
<td>With pressure relief measures (2)</td>
<td>Gas resistant membrane (3)</td>
<td>3.5 (fail)</td>
</tr>
<tr>
<td>Office building with basement car park (Building Type C)</td>
<td>3</td>
<td>Cast in-situ grade 1 ground-bearing basement slab (1)</td>
<td>Ventilated basement car park (4)</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Office building with basement plant rooms (Building Type C)</td>
<td>3</td>
<td>BS8102 grade 3 waterproofed basement (3)</td>
<td>No external ventilation measures (6)</td>
<td>No additional gas resistant membrane</td>
<td>3</td>
</tr>
<tr>
<td>Large floor plan retail commercial Industrial building, at grade A (Building Type G)</td>
<td>2.5</td>
<td>Cast in-situ ground-bearing slab (1)</td>
<td>No ventilation measures (0)</td>
<td>Gas resistant membrane (3)</td>
<td>2.5</td>
</tr>
<tr>
<td>Suspended floor slab (1.5)</td>
<td>6F2 sub-base + geo-composite gas dispersal layer (2)</td>
<td>Low voltage polyethylene void former layer and low level side vents (3)</td>
<td>Damp proof membrane (6)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**A) The combinations of measures given in Table F.14 are examples of how the minimum required score could be achieved. Other combinations of measures might be more appropriate for a particular building.**

**B) Refers to grades of waterproofing protection as defined in BS 8102:2009.**

**NOTE** An alternative approach in this case is to delineate the extent of the landfilled area and to introduce an in-ground venting/buffer trench if the new development is not situated directly over the landfilled area.
BS8485:2015 – CoP for the design of protective measures for methane and carbon dioxide ground gases in new building developments

Structural barrier - (7.2.2 and Annex A)

K Thornton
Principal Geo-Environmental Engineer, NHBC
Existing BS8485:2007

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

So what advice or provisions related to the structural barrier?
Existing BS8485:2007

Clause 7.1 stated ‘factors that should be considered in making decisions include’:

a) characteristic gas situation;
b) type of construction, foundations and ground slab detail;
c) size (particularly width) of building footprint;
d) end use of building (domestic or commercial, controlled or uncontrolled, occupancy, room size, etc.);
e) the nature of the management of maintenance of gas control facilities and service provision of the buildings; and
f) views of client/building owner.
Existing BS8485:2007

& Table 3 offered the following solution scores for specified floor slabs or substructure

<table>
<thead>
<tr>
<th>Floor slabs</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block and beam floor slab</td>
<td>0</td>
</tr>
<tr>
<td>Reinforced concrete ground bearing floor slab</td>
<td>0.5</td>
</tr>
<tr>
<td>Reinforced concrete ground bearing foundation raft with limited service</td>
<td>1.5</td>
</tr>
<tr>
<td>Reinforced concrete cast in situ suspended slab with minimal service</td>
<td>1.5</td>
</tr>
<tr>
<td>Reinforced concrete ground bearing foundation raft with limited service</td>
<td>1.5</td>
</tr>
<tr>
<td>Reinforced concrete cast in situ suspended slab with minimal service</td>
<td>1.5</td>
</tr>
<tr>
<td>Reinforced concrete cast in situ suspended slab with minimal service</td>
<td>1.5</td>
</tr>
<tr>
<td>Fully tanked basement</td>
<td>2</td>
</tr>
</tbody>
</table>

*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.*
BS8485:2007 Vs. BS8485:2015
Why Changes are Proposed?

In terms of Structural Barrier Steering Committee concluded that:

• *Existing standard* - no real guidance on common floor slabs/substructure design & their relative performance as a structural barrier to ground gas

• *Existing standard presents solution scores for floor slab types but lacked explanation on how these were derived*

• *Details for basements was particularly lacking. A solution score given for ‘fully tanked basement’ but no explanation was given to what this meant in terms of construction*
Proposed Revisions - BS8485:2015

Structural barriers - (7.2.2 and Annex A)

• Proposed revision recognises that ground floor slab and/or substructure construction provide varying degrees of resistance to inhibit the passage of gas and/or influence other design elements

• New Annex A – Introduced to offer informative details on commonly used foundation & floor slabs & sub structure elements
Proposed Revisions - BS8485:2015

Structural barriers - (Annex A)

- Aids understanding & appreciation of scoring in Table 4a
- Details associated influences in relation to other elements of the gas protection solution; (i.e. venting opportunities and membrane specifications) OR
- Discusses implications to the ground gas regime for certain types of substructure (e.g. potential influence of Vibro stone columns)
Proposed Revisions - BS8485:2015

Structural barriers - (7.2.2 and Annex A)

• **Four typical classes of sub structure selected**

- Precast suspended segmental sub floor
- Cast in-situ ground bearing floor with only nominal mesh reinforcement
- Cast in-situ monolithic RC ground bearing or suspended floors
- Basements- Grade 2 & 3 waterproofing requirements considered
### Table A.2 – Risk rating summary table

<table>
<thead>
<tr>
<th>Substructure/ground floor type</th>
<th>Gaps between member elements</th>
<th>Wall to floor crack</th>
<th>Structural cracking</th>
<th>Micro cracking</th>
<th>Overall risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast suspended segmental subfloors without and/or with bonded reinforced structural concrete topping (e.g. beam and block)</td>
<td>Moderate to high</td>
<td>Low</td>
<td>Low</td>
<td>Low to moderate</td>
<td>Very high</td>
</tr>
<tr>
<td>Cast in-situ ground bearing floor slab with mesh reinforcement for crack control constructed off a sound sub base (e.g. traditional ground bearing floor slab)</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate to high</td>
<td>High</td>
</tr>
<tr>
<td>Cast in-situ monolithic reinforced concrete ground bearing raft or suspended/semi-suspended cast in-situ reinforced concrete slab with minimal penetrations</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low to moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>Cast in-situ reinforced concrete basement constructed to provide Grade 2 (BS 8102:2009) waterproofing</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Cast in-situ reinforced concrete basement constructed to provide Grade 3 (BS 8102:2009) waterproofing</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Very low</td>
</tr>
</tbody>
</table>

A risk rating summary is now presented for ground ingress for different floor types & basements; based on typical key critical characteristics.
**Proposed Revisions - BS8485:2015**

**Structural barriers - (7.2.2)**

<table>
<thead>
<tr>
<th>Floor and substructure design (see Annex A)</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast suspended segmental subfloor (i.e. beam and block)</td>
<td>0</td>
<td>Breaches in floor slabs, such as joints and service entries, should be effectively sealed against gas ingress to maintain these performances.</td>
</tr>
<tr>
<td>Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended with minimal penetrations</td>
<td>1 or 1.5A)</td>
<td></td>
</tr>
<tr>
<td>Basement floor and walls in accordance with BS 8102:2009, Grade 2 waterproofing</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Basement floor and walls in accordance with BS 8102:2009, Grade 3 waterproofing</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

A) To achieve a score of 1.5 there should be a semi-raft slab with minimal penetrations cast in (see A.2.1.2).

*which translate to the gas protection scores proposed in Table 4a in section 7.2.1*
Proposed Revisions - BS8485:2015

Structural barriers – Your views count

• Is Annex A useful; does it offer sufficient detail/advice to aid understanding & appreciation of scoring?
• Are the four selected classes of sub structure right?
• Do you agree with the solution scores?
• Has a key critical characteristic been overlooked?
• Or; Any thing else?
Revision to BS8485:2007
EPUK Consultation Workshop
on Draft for Public Consultation

March 16, 2015

Part 6: Ventilation measures (7.2.2 and Annex B)

Richard Owen - ARUP
Table 3  Solutions scores

<table>
<thead>
<tr>
<th>PROTECTION ELEMENT/SYSTEM</th>
<th>SCORE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Venting/dilution (see Annex A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) A)</td>
<td>2.5</td>
<td>Ventilation performance in accordance with Annex A.</td>
</tr>
<tr>
<td>Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) A)</td>
<td>2.5</td>
<td>If passive ventilation is poor this is generally unacceptable and some form of active system will be required. There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive pressurization. Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F [5] and IStructE guidance [6].</td>
</tr>
<tr>
<td>Ventilated car park (basement or undercroft)</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Existing BS8485:2007 guidance – Annex A
“Estimation of underfloor ventilation and pressurization performance”

• Estimate surface emission rate.

• Analysis of passive ventilation capacity by one of 3 methods:
  - Simple dilution calculations (BS 5925 and CIRIA R149);
  - Tables in PiT;
  - Specific CFD modelling for proposed system at a site.

• Analysis of active ventilation and positive pressurization systems – use guidance in CIRIA R149 for required air flow, then provide sufficient fans.

• Performance of passive systems defined as ‘Very Good’ to ‘Unsuitable’ after PiT.
**Table A.1 Summary of gas dispersal characteristics of different ventilation media on idealized foundations**

<table>
<thead>
<tr>
<th>Gas regime</th>
<th>Methane concentration % v/v</th>
<th>Emission rate m/s</th>
<th>Characteristic situation</th>
<th>Open void</th>
<th>Polystyrene shunting</th>
<th>Geocomposite drainage blanket</th>
<th>20 mm single size gravel blanket</th>
<th>20 mm single size gravel blanket with interleaved pipes at 3 m centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>0.005</td>
<td>Poor</td>
<td>Adequate</td>
<td>Adequate</td>
<td>Adequate</td>
<td>Adequate</td>
<td>Adequate</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>0.005</td>
<td>Fair</td>
<td>Very good</td>
<td>Good</td>
<td>Very good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>0.01</td>
<td>Good</td>
<td>Very good</td>
<td>Good</td>
<td>Very good</td>
<td>Very good</td>
<td>Excellent</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
<td>0.005</td>
<td>Poor</td>
<td>Very good</td>
<td>Fair</td>
<td>Very good</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>0.01</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Unsuitable</td>
</tr>
<tr>
<td>F</td>
<td>20</td>
<td>0.05</td>
<td>Unsuitable</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Unsuitable</td>
</tr>
</tbody>
</table>

A) For open void space and polystyrene shuttered ventilation layers additional side ventilation provision can improve gas dispersal characteristics.

B) Gas dispersal characteristics based on maximum steady state concentration over 80% area of foundation, pipes interleaved at 3 m centres.

C) Assumptions sympathetic to detailed underside of foundation.

D) Emission rate values refer to equivalent total gas flow velocity from 50 mm diameter borehole and Peckson [10] assumption.

E) Characteristic situation after CIRIA Report 149 [13].
Revised guidance on ventilation protection – 2015 DPC

• Previous guidance too limited.
• Annex B much expanded & is now ‘normative’ (not ‘informative’).
• Different systems described and key design factors given.
• Range of scores for each different ventilation media/solution, depending on design and performance.
• Performance criteria after PiT maintained; CO$_2$ graph added.
• Maximum score remains 2.5 points for “very good performance”.
• Pressure relief pathway is 0.5 points, but must be effective.
• Positive pressurization differentiated from active abstraction.
• Different designs of polystyrene shuttering and geocomposites considered.
### Table B.4 – Relative dispersal effectiveness of different gas dispersal layer media

<table>
<thead>
<tr>
<th>Dispersal layer media</th>
<th>Dispersal effectiveness</th>
<th>Table 4b maximum points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear void</td>
<td>Very good</td>
<td>2.5</td>
</tr>
<tr>
<td>Polystyrene shuttering</td>
<td>Fair/good/very good(^B)</td>
<td>2.5</td>
</tr>
<tr>
<td>Cuspated geocomposite drainage blanket (min. 25 mm thickness)</td>
<td>Fair/good</td>
<td>1.0</td>
</tr>
<tr>
<td>Single size (no fines) granular aggregate blanket with perforated pipe gas drains</td>
<td>Fair/good</td>
<td>1.0</td>
</tr>
<tr>
<td>Single size (no fines) granular aggregate blanket</td>
<td>Poor</td>
<td>0.5</td>
</tr>
<tr>
<td>Well graded granular aggregate blanket (e.g. MOT Type 1 or Type 2 aggregate)</td>
<td>Inadequate</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^A\) Lower points score will apply if the guidance in **B.5** to **B.10** are not fully complied with.

\(^B\) There are a range of types and sizes of polystyrene shuttering which have differing dispersal effectiveness **(B.7)**
Revised guidance on ventilation protection – 2015 DPC

Figure 1 – Polystyrene void formers

a) Round leg, high voidage void former (manufactured for gas dispersal layer)

Figure 1 – Geocomposite void former

Square leg, lower voidage void former (manufactured primarily as temporary formwork)
Table 4b – Gas protection scores for ventilation protection measures

<table>
<thead>
<tr>
<th>Protection element/system</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)</td>
<td>0.5</td>
<td>Whenever possible it is good practice to install a pressure relief pathway (as a minimum) in all gas protection measures systems. If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.</td>
</tr>
<tr>
<td>(b) Passive sub floor dispersal layer: Clear void</td>
<td>1.5 to 2.5</td>
<td>The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B. Passive ventilation should always be designed to meet at least “good performance”, as described in Annex B. A score of 2.5 points should only be assigned if the layer achieves “very good performance”. The maximum score for a particular media type should not be exceeded unless design calculations demonstrate a “very good performance” will be achieved.</td>
</tr>
<tr>
<td>Polystyrene void former blanket</td>
<td>1.5 to 2.5</td>
<td></td>
</tr>
<tr>
<td>Geocomposite void former blanket</td>
<td>0.5 to 1.5</td>
<td></td>
</tr>
<tr>
<td>No-fines gravel layer with gas drains</td>
<td>0.5 to 1.5</td>
<td></td>
</tr>
<tr>
<td>No fines gravel layer</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>(c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers.</td>
<td>1.5 to 2.5</td>
<td>This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least “very good performance”, as described in Annex B.</td>
</tr>
<tr>
<td>(d) Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket.</td>
<td>1.5 to 2.5</td>
<td>This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient “coverage” of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least “very good performance”.</td>
</tr>
<tr>
<td>(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)</td>
<td>4</td>
<td>Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations 2000. Approved Document F, Ventilation [12] and IStructE guidance [13].</td>
</tr>
</tbody>
</table>
Comments on new ventilation guidance?

• Are ranges of scores reasonable? workable?
• Too prescriptive on scores/media?
• Flexible enough to support good design?
• Strict enough to limit ‘over-scoring’?
• Other comments?

(Ventilation design and performance to be clearly set out in design report – 8.3.2)
Gas resistant membranes should be:

a) Sufficiently IMPERVIOUS to methane and carbon dioxide

b) Sufficiently DURABLE to remain serviceable for the ANTICIPATED LIFETIME of the building and DURATION OF GAS EMISSIONS

c) Sufficiently STRONG to withstand in SERVICE STRESSES (e.g. due to ground settlement if placed below a floor slab)

d) Sufficiently STRONG to withstand the INSTALLATION PROCESS and FOLLOWING TRades until covered

e) Capable after installation of providing a COMPLETE BARRIER to the entry of the relevant gas
The person specifying the membrane should consider the combination of a particular membrane’s properties to assess whether it is suitable in any given situation. The specified membrane and the reasons for its selection should be described in the design report stage.

A verification plan for the installation of the membrane should be part of the detailed design.

A gas protection score should only be assigned to a membrane which is formed of a material which has a suitably low gas permeability and has been installed so that it completely seals the foundation and does not sustain damage from in-service stresses.
Gas resistant membranes meeting **ALL** of the above requirements – **HERO** or **ZERO**

### Table 4c – Gas protection score for the gas resistant membrane

<table>
<thead>
<tr>
<th>Protection element/system</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas resistant membrane meeting all of the following requirements:</td>
<td></td>
<td>The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints.</td>
</tr>
<tr>
<td>- sufficiently impervious to the gases with a methane permeability &lt;40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with ISO 15105-1 manometric method);</td>
<td>2</td>
<td>If a membrane is installed that does not meet all the requirements then the score is zero.</td>
</tr>
<tr>
<td>- sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- sufficiently strong to withstand in service stresses (e.g. settlement if placed below a floor slab);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- capable, after installation, of providing a complete barrier to the entry of the relevant gas; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- verified in accordance with CIRIA C735 [N1]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SUBGRADE / SUB BASE

No sharp objects

Rolled and compacted as necessary

No Standing water

No significant voids

- Dusted Aggregate
- Venting Layer
- Geotextile
Proprietary Membrane Materials

Performance based on:

a. Polymers used (non-recycled)
b. Thickness & Mass
c. Reinforcement (scrim)
d. Inclusion of an aluminium core

Remember:

• Materials selection based on design requirements
• need good installation
• Not a benign environment
Proprietary Membrane Materials

- flexible polypropylene (FPP)
- high density polyethylene (HDPE)
- low density polyethylene (LDPE) or linear low density polyethylene (LLDPE)
- reinforced LDPE with an aluminium core
- HDPE reinforced polypropylene (FPP) with aluminium core
- HDPE/ethylenevinylalcohol (EVOH)/HDPE-sandwich
- spray applied asphalt-latex membranes (bitumen/polystyrene emulsions)
- OTHERS
Membrane Gauge (Thickness)

- Based on the application it is being used for
- **NOT** the thickness of the reinforcement scrim
- Too thick - difficult to install, increased cost
- Too thin – can’t weld, easy to damage
- **Mass** – 0.5mm @ 450g/m²
  - LDPE >0.91g/cm³
  - HDPE >0.94g/cm³
Jointing and Detailing

• Jointing can be achieved by either tape or welding methods (ensure product compatibility)
• Professionals tend to weld – it's quicker, requires less product and typically achieves a very high standards of joint
• In either case PRESSURE, and in many cases HEAT, needs to be applied to achieve an ACCEPTABLE BOND
Gas Resistant Membrane Installation
How it shouldn’t be done:
What do we do about internal walls?
Any offcuts?
How it shouldn’t be done…
Other trades?

Follow on trade damage
- Lack of understanding of importance of gas protection
- Lack of care
- Lack of site management
- Timing of validation?

Solutions
- Tool box talks
- Protection of membrane
- Use of a ‘skid’

Time and cost implications?
Thank you

Discussion / Questions?

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BS DPC 8485 – Verification & reporting etc.

MIKE SMITH

EPUK 16 MARCH 2015
Transparency & responsibility

What was done by whom and why

Occupiers and owners

Regulators

Court
Investigation
Assessment
Selection of design solutions
Design
Implementation
Verification – in accordance with CIRIA C735
Occupation
Maintenance
COURT
8. Implementation, verification & reporting

- 8.2 Site conditions and characterization of the ground gas regime
- 8.3 Design phase
  - 8.3.1 Construction and building related details
  - 8.3.2 Gas protection design products specifications and justification
  - 8.3.3 Recommended verification approach
  - 8.3.4 Installation and verification phase

- What should be included in the report at each stage
The Commenting Process
BSI Draft Review System (DRS)

http://drafts.bsigroup.com/

Comment template
BSI’s Draft Review System

- Need to register on first use
- Lets you see and comment on sections of the DPC – requires comment (e.g. why change needed) and suggested wording.
- Please indicate paragraph & line number etc. to which the comment refers.
- Guidance on how to use is hidden in “help” tag
- Cannot download whole document
- Cannot insert Tables, figures etc.
Send completed template to:

michaelsmith16@btconnect.com

jessymathew@bsigroup.com

(secretary of BSI EH4 soil quality)