Appropriate Gas Protection Measures

Introduction

This document is aimed to providing guidance for the use of protective measures for ground gases Methane, Carbon Dioxide, Radon, VOCs, and moisture protection, for new buildings/structures and remediation of existing buildings/structures. The guidance contained within this is based upon the most up to date standards and guidance from CIRIA, BRE, NHBC and BS 8485: 2015 +A1:2019.

For avoidance of doubt, the information within this document is provided in good faith, and is prepared for the use of Specifiers, Installers, Users and Verifiers of Delta Membrane Systems Ltd products.

This guidance document does not provide a comprehensive review of all guidance, and its use extends as far as to provide a summary, quick assessment of guidance documentation. As with waterproofing design philosophy in BS 8102:2022 for the design of waterproofing systems, BS 8485:2015 +A1:2019 provides a "solutions choice" flow chart (fig 5 BS8485:2015+A1:2019). Appropriate gas protection measures should be selected using this method based on the CS (Characteristic Score) of each site.

The construction, use of the building, it's future maintenance, control of structural changes to the building requiring assessing, as these factors influence risks posed by ground gases. Verification of Ground Gas Protection Systems design should be verified by an Independent third party along with monitoring of the installation and integrity testing in accordance with BS 8485:2015+A1:2019 and CIRIA 735. Installation should be strictly in accordance with Product Installation Guidelines and Product Data Sheets. Installing operatives should be trained and Registered with Delta Membrane Systems Limited or hold NVQ level 2 in Gas Membrane Installation Assessment.

The information provided here and extracted elements of BS 8485:2015+A1:2019 are to provide a quick guide to appropriate specification of Delta Membrane Systems Limited's Ground Gas Protection Systems. For full details on complete Design, Specification, Installation, Verification and monitoring we would advise consulting BS 8485:2015+A1:2019, CIRIA 735 & 748.

For additional assistance please contact Delta Technical on: 01992 523523 or info@deltamembranes.com.

Figure 3 — Ground gas site characterization and assessment flow chart

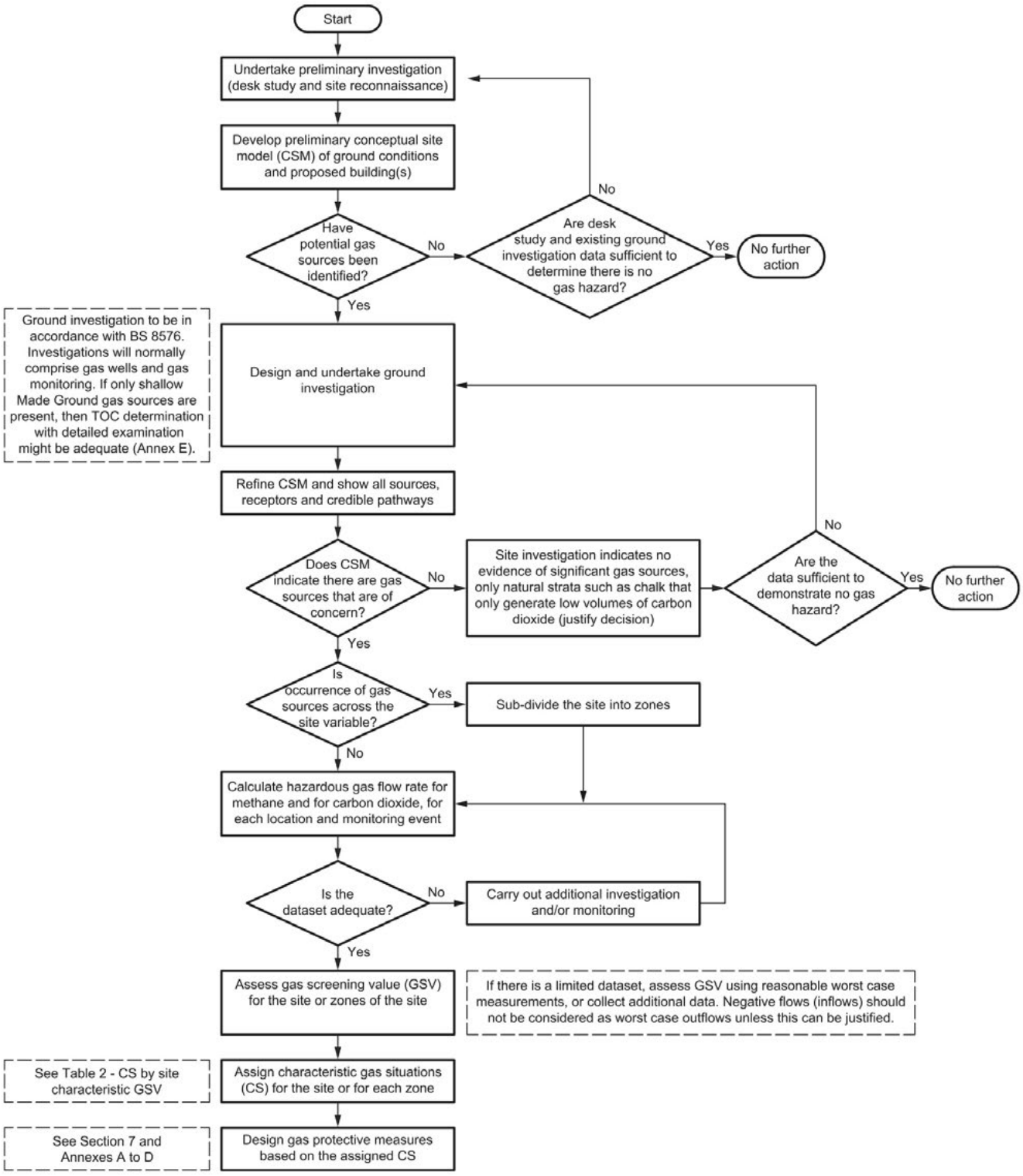

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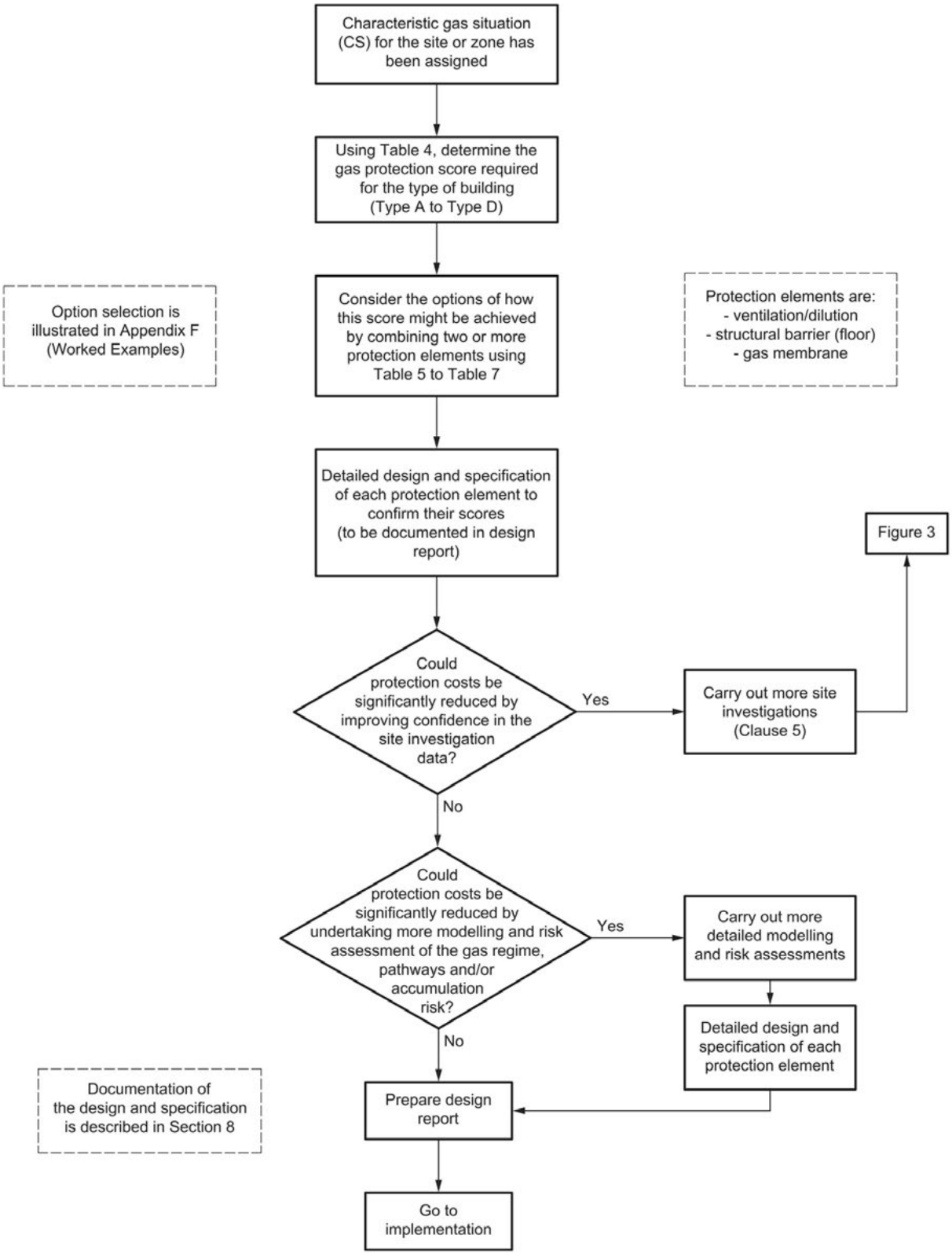
Figure 5 — Solutions choice flow chart



Characteristic Gas Situation (CS) for each site is quantified using conceptual site models and/or gas monitoring data from each site. Based on the results from these, a CS Score can be given to each site.

The CS Score ranges from CS1 (very low) to CS6 (very high), see Table 2 BS8485:2015 +A1:2019 as shown below.

Table 2 — CS by site characteristic GSV

CS	Hazard Potential	Site characteristic GSV [A]) L/h	Additional Factors
CS1	Very low	<0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	0.07 to <0.7	Typical measured flow rate <70 L/h (otherwise consider an increase to CS3)
CS3	Moderate	0.7 to <3.5	-
CS4	Moderate to high	3.5 to <15	-
CS5	High	15 to <70	-
CS6	Very High	>70	-

[A]) The figures used in this column are empirical.
NOTE The CS is equivalent to the characteristic GSV in CIRIA C665 [6].

Once the CS for each site has been assessed, it is necessary to categorise the building type, BS 8485: 2015+A1:2019 details four building types:

Type A: Private ownership with no building management controls – Private Housing for example.

Type B: Private or commercial property with central building management control of any alterations to building – managed apartments, multiple occupancy offices and some retail for example.

Type C: Commercial building with central building management control of any alterations and maintenance including gas protection measures. Some retail premises, schools, hospitals, and leisure centres for example.

Type D: Industrial style building having large volume internal spaces that are well ventilated, factory shop floors, retail park sales buildings and warehouses for example.

Table 3, BS8485:2015 +A1:2019 provides summary of the building types, for greater and more depth of definition of building types please refer to section 7, BS 8485:2015 +A1:2019.

Table 3 — Building Types

	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial/ public, possible multiple	Commercial/public	Commercial/industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small/medium	Small to large	Large industrial/retail park style

From the design CS and building type a minimum level of gas protection (0- 6.0) can be determined in accordance with Figure 4 BS8485:2015 +A1:2019. As shown below:

Table 4 — Gas protection score by CS and type of building

	Minimum gas protection score (points)			
CS	High risk		Medium risk	Low risk
	Type A building	Type B building	Type C building	Type D building
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 [A)]	5.5 [A)]	4.5	3.5
5	— [B)]	A1 6 A1 [A)]	5.5	4.5
6	— [B)]	— [B)]	A1 — [B)] A1 [A)]	A1 6 A1

[A)] Residential buildings should not be built on CS4 or higher 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.

[B)] The gas hazard is too high for this empirical method to be used to define the gas protection measures.

Having assessed the gas protection score for the building or part thereof, a combination of elements/measures should be chosen from the following 3 tables:

- Table 5 – Gas protection scores for the structural barrier
- Table 6 – Gas Protection scores for the ventilation measures
- Table 7 – Gas Protection score for the gas resistant membrane

Table 5 — Gas protection scores for the structural barrier

Floor and substructure design (see Annex A)	Score [A)]
Precast suspended segmental subfloor (i.e. beam and block)	0
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations	1 or 1.5 [B)]
Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing [C)] [D)] [D)]	2
Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing [C)] [D)] [D)]	2.5

[A)] The scores are conditional on breaches of floor slabs, etc., being effectively sealed.

[B)] To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in (see A.2.2.2).

[C)] The score is conditional on the waterproofing being provided by a suitable structural barrier with the design and detailing of the walls and floor meeting the requirements for Type B protection. The score cannot be assigned for Type A (waterproof membrane) or Type C (drained cavity wall).

[D)] If a membrane is installed beneath and around the basement to provide Type A waterproofing (BS 8102:2009), it can be assigned a gas protection score in accordance with Table 7, if it meets all the criteria for a gas resistant membrane in that table.

Geo-composite blankets

Pro Void Vent 25 should be at least 25mm, they are not suitable for use in CS4 or higher unless the width of the building is small (less than 8m). For small to medium width buildings (up to 15m) side ventilation should be 1500mm^2/m run of wall.

For larger building widths (over 15m) side ventilation should be at least 2000mm^2 /m run of wall. Side ventilation should be provided on at least 2 opposite sides of the structure.

Pro Void Vent 25

A point score of 1.5 in Table 6 can be applied for Pro Void Vent 25 in buildings up to 15m wide, this should be reduced to 1.0 or even 0.5 for larger or exceptionally large widths of buildings.

Further information and details on design of ventilation measures are provided in Annexe B BS 8485:2015+A1:2019 and should be referred to, as if in accordance with figures B.6 or B.7, a good performance can be demonstrated prior to a point score of 2.5 being applied.

Pro M1 Gas membrane, Pro Liquid Gas Barrier ('LGB'), Delta LM 800, Delta AT 800, Pro Titan, Pro Titan Bond and Pro Titan Tank will satisfy the requirements of Table 7 and provide a 2-point score for the Gas Protection Membrane. From CIRIA C748, Guidance on the use of plastic membranes as VOC barriers, states, "the membranes for building protection are most likely to be placed over the floor slab or below the floor slab on a prepared sub – base or ventilating layer". The membrane is not likely to be in direct contact with the

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Pro Void Vent 25 Cont...

The vapour concentration should be low, which will minimise the risk of chemical degradation of the membrane. Care must be taken to mitigate and prevent through design direct contact of the barrier membrane with the source or vapours. Where it is unavoidable to prevent direct contact of the barrier membrane to the source, appropriate barrier selection should include for the potential of direct contact with the source contaminant. Pro Titan, Pro Titan Bond and Pro Titan Tank are suitable VOC barrier membrane.

Table 6 — Gas protection scores for ventilation protection measures

Protection/element systems	Score	Comments
(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)	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed 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.
(b) Passive sub floor dispersal layer: Very good performance: Good performance: Media used to provide the dispersal layer are: • Clear void • Polystyrene void former blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	2.5 1.5	Performance criteria for methane and carbon dioxide are shown in Figure B.6 and Figure B.7, respectively. 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 be designed to meet at least "good performance", see Annex B.
(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	1.5 to 2.5	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 "good performance", as described in Annex B.
(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	1.5 to 2.5	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 "good performance"..
(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to Buildings Regulations 2000, Approved Document F [9].

Table 7 — Gas protection scores for ventilation protection measures

Protection/element systems	Score	Comments
Gas resistant membrane meeting all of the following criteria: • sufficiently impervious A1, both in the sheet material A) and in the sealing of sheets and sealing around sheet penetrations, to prevent any significant passage of methane and/or carbon dioxide through the membrane; A1 • sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; A1 Text deleted A1 • sufficiently strong A1 B) A1 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); and to withstand in-service stresses (e.g. settlement if placed below a floor slab); • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735 [N1].	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. A1 Text deleted A1 If a membrane is installed that does not meet all the criteria in column 1 then the score is zero.

A) A1 A membrane with a methane gas transmission rate <40.0 ml/day/m2/atm (average) for sheets and joints (tested in accordance with BS ISO 15105-1:2007 manometric method) is regarded as sufficiently impervious.

B) For example, reinforced LDPE (virgin polymer) membranes having a minimum mass per unit area of 370 g/m2 and not significantly less than 0.4 mm thickness between the reinforcement scrim (tested in accordance with Procedure D (2 mm diameter tip) of BS EN ISO 9863-1:2016) installed above floor slabs are considered sufficiently strong to meet the performance criteria (see also C.3). Thicker and more robust membranes or an additional membrane protection layer should be installed directly beneath cast-in-situ floor slabs. A1

7:3 In-ground Pathway Intervention

A site which is impacted by migratory gases from an off-site source should be protected by pathway intervention methods, which, if successfully validated, could also remove the requirement for further protection. The gas regime on the site should be fully characterised and include identification of potential pathways from the off-site source.

Note 1: methods of pathway intervention include simple vertical membrane installations, vent trenches, rows of stone columns, activated trenches and proprietary systems.

Note 2: for residential dwellings, management and maintenance is only acceptable where pathway intervention measures (e.g., venting trenches) are beyond the extent of the building(s), on or close to the boundary of the property in a position where access can be guaranteed.

7.4 Detailed Design

Once the design measures have been selected in accordance with 7.2, these should be developed into a detailed design supported by detailed drawings and specifications. The detailed design should then be described in the Design Report (see BS 8485:2015+A1:2019, Point 8.3). The person who has selected the design measures and whoever is preparing the detailed design should liaise during the development of the detailed design.

Note: This consultation might result in a decision that the selected design measures cannot be implemented for practical reasons and consequently a redesign required regarding what design measures are to be employed.

Table A.2 — Risk rating summary

	Risk Ratings				
Substructure/ground floor type	**Gaps between member elements**	**Wall to floor crack**	**Structural cracking**	**Micro cracking**	**Overall risk rating**
Precast suspended segmental subfloors without and/or with bonded reinforced structural concrete topping (e.g. beam and block)	Moderate to high	Low	Low	Low to moderate	Very high
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)	Low	High	Moderate	Moderate to high	High
Cast in situ monolithic reinforced concrete ground bearing raft or suspended/ semi-suspended cast in situ reinforced concrete slab with minimal penetrations	Low	Low	Low	Low to moderate	Medium
Cast in situ reinforced concrete basement constructed to provide Grade 2 or A_1 Grade 3 A_1 (BS 8102:2009) waterproofing	Low	High	Moderate	Moderate to high	High

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