



Dearden Ave, Bury

Remedial Strategy Report

For: Isatis Construction Ltd

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INTRODUCTION

This *Remedial Strategy Report* has been prepared at the request of Isatis Construction Ltd. Instructions to proceed with this report were received in September 2025.

This report pertains to a 525m² site located to the south of Deardens Street, Bury, at the approximate postcode BL8 2PB. The National Ordnance Survey Grid Reference for the centre of the site is E379117, N410322.



Figure 1: Extract of proposed layout

A full version of the Proposed Development Plan is contained in Appendix 1.

Scope

The purpose of this report is to set out the remedial measures required to be completed on site. Previously proposed Remedial Measures/Remedial Strategy are included in following report: -- **EPS Consulting, 'Phase I & II Geo-Environmental Assessment Report, Deardens Street, Bury, Greater Manchester, BL8 2BT, ref: UK21.5294, dated: April 2021.**

Planning Permission and Conditions

The Deardens Street site is subject to Planning permission (Application Number 66396), granted by Bury Council on the 27th April 2021. The planning permission was granted for the: -- *Erection of 5 no. townhouse dwellings*" subject to conditions, this report is concerned with conditions 4 & 5.

Condition 4 of the above planning permission requires:

"No development shall commence unless and until:-

- A contaminated land Preliminary Risk Assessment report to assess the actual/potential contamination and/or ground gas/landfill gas risks at the site shall be submitted to, and approved in writing by, the Local Planning Authority;*
- Where actual/potential contamination and/or ground gas/landfill gas risks have been identified, detailed site investigation and suitable risk assessment shall be submitted to, and approved in writing by the Local Planning Authority;*
- Where remediation/protection measures is/are required, a detailed Remediation Strategy shall be submitted to, and approved in writing by, the Local Planning Authority.*

Reason. The scheme does not provide full details of the actual contamination and subsequent remediation, which is required to secure the satisfactory development of the site in terms of human health, controlled waters, ground gas and the wider environment and pursuant to National Planning Policy Framework Section 11 - Conserving and enhancing the natural environment."

Condition 5 of the above planning permission requires:

Following the provisions of Condition 4 of this planning permission, where remediation is required, the approved Remediation Strategy must be carried out to the satisfaction of the Local Planning Authority within agreed timescales; and A Site Verification Report detailing the actions taken and conclusions at each stage of the remediation works, including substantiating evidence, shall be submitted to and approved in writing by

the Local Planning Authority prior to the development being brought into use. Reason. To secure the satisfactory development of the site in terms of human health, controlled waters and the wider environment and pursuant to National Planning Policy Framework Section 11 - Conserving and enhancing the natural environment.

The above EPS Consulting, 'Phase I & II Geo-Environmental Assessment' was submitted in support of the discharge of conditions. To avoid repetition, detailed findings of the above reports have not been reproduced in this report, but selected parts of the reports have been summarised below for clarity and completeness (a copy of the report is included in the Appendices) :

EPS “Phase I & II Geo-Environmental Assessment” Report (2021)

This report was undertaken in August 2021. EPS undertook intrusive site investigation, comprising:

- 4 No. four window sample boreholes to a depth of 5.0m below ground level (bgl) using a track-mounted percussive rig.
- Installation of gas and groundwater monitoring standpipes at selected locations (no monitoring was completed).
- Chemical and geotechnical laboratory testing.

The exploratory hole locations were arranged as follows:



Figure 1 - EPS sampling location plan.

The investigation involved drilling four boreholes to a maximum depth of 5.0m and found made ground to extend between 1.80-3.0m and varied from sandy clayey gravel with frequent brick, concrete, plastic and dark grey sandy gravelly clay with similar constituents. A dark grey to black ashy slightly sandy gravel with evidence of coal and slag/clinker was also noted. Natural soils were recorded as light brown gravelly clay, clayey gravel or clayey gravelly sand. This variability is considered typical of Glaciofluvial Deposits. Water was encountered in two of the window samples at a depth of 4.4 to 4.6m

Chemical Testing Of Soils

Chemical testing of soil samples was undertaken, and GAC exceedances were noted and are reported in the EPS Consulting, '*Phase I & II Geo-Environmental Assessment*' – see extracted table below taken from Section 7.1.3

Contaminant	Adopted Screening Criteria (mg/kg)	No. of Exceedances	Highest Concentration (mg/kg) & Location (m bgl)
Lead	200	1	215 (WS02 1.70-1.80)
Benzo(a)pyrene	5	2	16.2 (WS02 1.70-1.80)
Benzo(b)fluoranthene	2.6	2	22.64 (WS02 1.70-1.80)
Dibenzo(ah)anthracene	0.24	2	1.76 (WS01 0.10-0.20)
TPH Aromatic EC16-EC21	260	1	488 (WS01 0.10-0.20)
TPH Aromatic EC21-EC35	1100	1	1714 (WS01 0.10-0.20)

Due to the above soils exceedances a cover system is to be placed in garden areas, to protect end users from underlying contaminated soils, see extract below from EPS Consulting, '*Phase I & II Geo-Environmental Assessment*'

In this instance, a soil-based cover system is considered suitable to act as a 'breaks-layer' between the contaminant source (made ground) and future receptors. It should be noted that all made ground does not necessarily need to be excavated but a sufficient quantity may require excavation and disposal in order to facilitate the suggested remedial measures below.

The depth of cover system has been developed with reference to the BRE publication: *Cover Systems for Land Regeneration: Thickness Design of Cover Systems for Contaminated Land* (BRE, Mar 2004). The results of cover system calculation indicate an overall cover thickness of approximately 560mm could be considered suitable based on maximum concentrations of PAHs at the site, however, it would be considered prudent to round this up to **600mm** given the variability in chemical composition of the made ground and the lack of robust statistical analysis due to the aforementioned variability in the dataset. Any cover system installed should have a geotextile at the base to prevent mixing of soil. It should also be noted that a proportion of made ground may need to be excavated and disposed of to achieve the required depths. It may be appropriate to install 300mm of clean imported 'subsoil' at the base of the cover system, with appropriate topsoil making up the final 300mm.

Ground Gas Monitoring

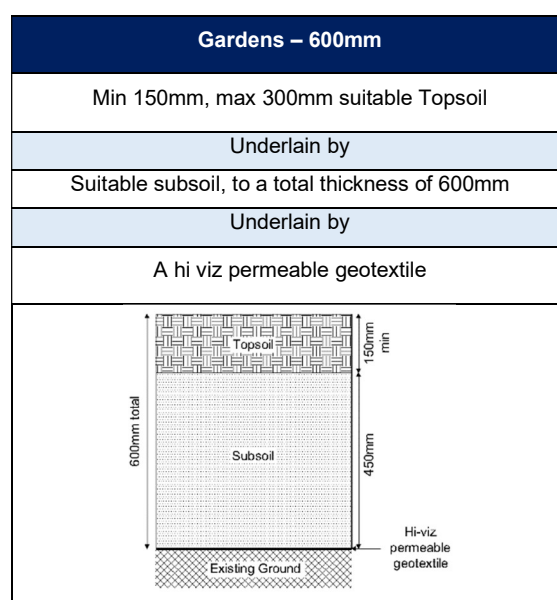
Ground gas monitoring was not completed, thus a ground gas protection system shall be constructed, in accordance with the recommendations of Chapter 7.1 from EPS Consulting, '*Phase I & II Geo-Environmental Assessment*', see extract below

No ground gas risk assessment was undertaken as part of this investigation, however, deep made ground has been recorded along with an infilled former waterway in part of the site. It has not been possible to dismiss the potential risks of ground gas generation and therefore additional works involving a period of ground gas monitoring are recommended. Otherwise, gas protection measures will be required in accordance with BS8485:2015 '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*'.

Remedial Strategy for Human Health

Installation of a Cover System

As detailed above, a cover system will be required to break any pathways between the Made Ground and the end user. The cover system is to be 600mm thick in gardens.



Alternatively, when excavating for the cover system, if the base of the Made Ground is found shallower than 600mm in gardens this constitutes source removal, so in this case, install a Isatis Construction Ltd standard garden rather than a 'cover system'.

Guidance for the correct installation of cover systems is contained in Appendix 3. The topsoil and subsoil shall be imported and must be validated as detailed below to ensure their suitability for use.

Validation of Clean Cover System

The installation of the clean cover system must be verified in accordance with the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG) '*Verification Requirements for Cover Systems*' (version: 4.1, dated: June 2021), as follows:

- Details of the source of the cover material;
- Waste transfer notes to provide evidence of source (for imported soils);
- Confirmation of cover depth by either measurement tape or topographical survey with photographs at a frequency of one pit per plot;
- Imported topsoil and subsoil is required to be tested at source prior to import to confirm suitability. All topsoil and subsoil, whether site-won or imported is required to be tested in-line with the below.

Both imported soil and site-won soil should be tested for the following determinants on the following frequency, in-line with YALPAG Guidance - *Verification requirements for cover systems* (version 4.1, June 2021):

Type	Number of Samples	Testing Schedule	Assessment Criteria
Greenfield / Manufactured Soils	1 per 50m ³ for topsoil 1 per 250m ³ for subsoil (minimum of 3 samples per source)	Standard metals and metalloids (as above), PAHs (16 USEPA Specification), asbestos, pH and soil organic matter	For garden areas: S4UL and C4SL GACs for a 'residential with plant uptake' end use For POS areas: S4UL and C4SL GACs for a 'residential public open space' end use

Once complete, the information gathered as recommended above should be compiled into a Validation Report for the site in line with the above referenced YALPAG guidance, detailing the completion of the remedial and verification measures.

The verification report shall include, as a minimum, the following:

- Site Name / location, developer name, development use
- Plot No / description of landscaped area (inc plan of inspection areas) and National Grid Reference
- Inspection visit date
- Description of remediation (as per agreed Remediation Strategy including depths / thickness checks, topographical readings)
- Material tracking information (including way tickets etc.)
- Name of groundwork's remediation contractor
- Name of supervising environmental consultant
- Site Specific chemical analysis results
- Verification Photographs (inc. remarks)
- Pass/fail and if material fails, how will this be managed i.e. removed, treated
- Detail any further remedial works and/or inspection
- 'Signed off'

A copy of the YALPAG '*Verification Requirements for Cover Systems; Technical Guidance for Developers, Landowners and Consultants*' (version: 4.1, dated: June 2021) is contained in Appendix 4.

Remedial Strategy for Ground Gas

Installation of Gas Protection Measures

Based on the recommendations of the EPS reports ground gas protection measures shall be incorporated to all 5 plots. The ground gas protection system shall be installed to CS3 level.

The proposed houses are **Type A** buildings in accordance with BS8485+A1 (2019). To protect the proposed Type A buildings against the CS3 ground gas risks identified, **4.5 points** must be achieved. The proposed construction elements to achieve the required points score are given below:

- beam and block floor construction is to be utilised. This achieves 0 points.
- ground gas resistant membrane is recommended. This achieves 2 points.
- A clear void passive venting layer with 'very good' performance is recommended. This achieves 2.5 points.

Further details on the above measures are included in the below tables:

Design Requirements	
A pre-cast suspended segmental subfloor (beam and block) This floor type contains many construction joints and discontinuities and can be affected by cracking. As such, it offers little resistance to the passage of ground gas and has high permeability.	0 points
and	
A passive subfloor dispersal layer – clear void connecting to periscopic vents terminating in vents above ground level To comply with BS8485+A1 (2019) and to achieve 2.5 points (for 'very good' performance): • the subfloor void must be at least 150mm thick, and; • the minimum area of side ventilation should be at least 1 No. standard 75mm x 225mm louvred grille airbrick every 2m of wall, and; • where there are multiple internal obstructions to air flow (caused by beams), there should be four or five times the area of the side vents provided in the internal obstructions (e.g. minimum 1 air brick per 1m of internal obstructions).	2.5 points
and	
A ground gas resistant membrane To comply with BS8485 (2015) + A1 (2019) and to achieve the 2 points, the gas resistant membrane must: • be made from virgin polymer and have a methane transmission rate of less than 40.0ml/day/m²/atm (average); • have lapped and taped joints and 'top hats' around service penetrations (make allowance for jointing) – joint the membrane in accordance with the manufacturer's specification (typically 150mm laps with double sided tape); • be chemically resistant to degradation by other contaminants that may be present; • be sufficiently impervious, both in the sheet material 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;	2 points

• be sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • be 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); and to withstand in-service stresses (e.g. settlement if placed below a floor slab); • be capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • be verified in accordance with CIRIA C735.	
	Total 4.5 points

Some membranes which meet the above required specification are:

- Visqueen 'Gas Barrier'
- Monarflex 'Reflex Super'
- Radbar 'Amber 2 Foil Barrier'
- Juta 'GP1'
- Alderburgh 'Alderprufe GRA'

All membrane installation must be undertaken to manufacturer's specification. An example of correct installation* is shown in Appendix 6.

Adequate ventilation through internal obstructions to be installed in line with above recommendations. Joints between sheets of gas membrane should be lapped (minimum overlap of 150mm) and taped between sheets with appropriate double-sided tape in accordance with the manufacturer's recommendations.

A set of example photographs of good practice installation are contained in Appendix 6.

Verification of Gas Protection Measures

The verification of the gas protection measures should be carried out in line with YALPAG '*Verification Requirements for Gas Protection Systems; Technical Guidance for Developers, Landowners and Consultants*' (version: 1.1, dated: December 2016). The following plan details the required actions to demonstrate the successful installation of ground gas protection on the site. In

accordance with BS8485 (2015) + A1 (2019), the verification shall include, as a minimum, the following:

The exact construction company appointed to install the gas protection measures is unknown at the time of writing. The installers should be trained and experienced in the installation of ground gas resistant membranes.

In line with CIRIA 735 (2014), CSVS shall independently verify the installation of the gas protection measures. A visual/pick plus air lance inspection method, shall be undertaken and this will be carried out at all plots. This will be undertaken following the laying of the beam and block pre-cast floor units and laying of the gas membrane, but prior to laying insulation and finishes.

The verifier will:

- Identify that the correct membrane has been used, including sealing / jointing tape and pre-formed components e.g. tophats, corners.
- Inspect the general condition of the membrane for rips, tears and punctures.
- Check that all jointing has been carried out to the manufacturer's specification.
- Check that the membrane has been installed correctly across cavities, including correct jointing in these areas.
- Check that service penetrations have been correctly sealed including jubilee clips correct welding, good detailing and correct lapping and jointing to the membrane at the base.
- Check that vents have been installed around the perimeter of the building in sufficient number and in the correct locations, including inspecting the condition i.e., not blocked or otherwise restricted.
- Check the presence of a clear >150mm clear void, including measuring that this is of a sufficient depth and the void has not been filled or otherwise compromised. Check that internal sleeper walls are also

vented to provide adequate flow-through within the void so that none of the walls are blocking off unvented sections within the void.

- Take photographs to provide evidence of the above.

verifier will record the above information using the a 'Ground Gas Resistant Membrane Inspection Record' sheet. An example of this is included in Appendix 6.

The verification report shall include:

- Objectives of the verification.
- A brief overview of the site conditions and summary of the ground gas regime.
- A description of the installation, including gas-resistant membrane manufacturer and type used (including sealing / jointing tape and pre-formed components e.g. top hats, corners). The manufacturer specification / datasheet shall be included.
- Installer and verifier and credentials of such organisations, i.e. level of competency of installer – NVQ Level 2 or general groundworker.
- Detailed description of any deviations from the specification provided in this report, with explanation and justification of such deviations.
- As-built construction drawings and product specifications of components used.
- A description of the verification approach – in this case visual inspection, including pick testing, at a rate of one per plot.
- Verification evidence – in this case photographic evidence of each verified plot at the frequency outlined above.
- Any record of relevant communications with regulatory bodies.

- Verification conclusions, including any future monitoring or management requirements (anticipated none in this case due to passive approach), and limitations of the measures installed.

When the above has been completed and prior to occupation, this information will be compiled in a validation / completion report which will be submitted to and approved in writing by the local planning authority.

A full version of YALPAG '*Verification Requirements for Gas Protection Systems; Technical Guidance for Developers, Landowners and Consultants*' (version: 1.1, dated: December 2016) is included in Appendix 5.

RECOMMENDATIONS

- Install a 600mm clean cover system in proposed gardens in line with the above detailed requirements.
- Install ground gas protection measures within all plots in line with the above detailed requirements.
- Validate all of the above remedial measures in line with the above detailed requirements.

APPENDIX 1

Do not scale drawings. All dimensions to be verified on site before proceeding with the work. All dimensions given in millimetres unless stated otherwise. All drawings to be read in conjunction with other consultants' drawings and specifications.

revision	drawn	date
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DEARDENS STREET

SHARED DRIVE

bin collection point

Existing metal fence retained with 2m high timber fence erected behind

2m high timber fence and gate

2m high timber fence to boundary

2m high timber fence to garden boundaries

Trees to be planted to replace any losses due to development

DEARDENS FOLD

PLANNING

PROJECT TITLE: LAND TO SOUTH OF DEARDENS STREET, BURY. PROPOSED TOWNHOUSES TO VACANT LAND	PROJECT NO: 2411_02
REVISION: B	

DRAWING TITLE: SITE PLAN	DRAWING NO: 003
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SCALE: 1:200@A3	DATE: 13.12.24	DRAWN BY:
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APPENDIX 2

EXAMPLE INSTALLATION OF CLEAN COVER SYSTEM

The following example shows the clean cover system installation in line with the following requirements:

- A 600mm clean cover system comprising:
 - A minimum of 150mm topsoil, underlain by
 - 300mm subsoil, underlain by
 - 150mm gravel break layer
 - A hi-viz geotextile marker

It should be noted that most cover systems require **either** a gravel break layer **or** a hi-viz geotextile marker, but the below example uses both:

Figure 1: First, the gardens are dug out to 600mm below FFL and lined with a hi-viz geotextile marker:



Figure 2: The geotextile is overlain by a 150mm clean stone break layer.



Figure 3: The break layer is overlain by 300mm sub-soil, seen here before spreading across the garden:



Figure 4: The sub-soil is overlain by 150mm topsoil to FFL:



Figure 5: The gardens are finished with turf. The overall cover system depth is 600mm:



EXAMPLE CLEAN COVER SYSTEM VALIDATION

The following example shows validation of a clean cover system in line with the following requirements:

- A 600mm clean cover system comprising:
 - A minimum of 150mm topsoil, underlain by
 - 450mm subsoil

Best practice requires three photos as follows:



Photograph 1 – Identifies the plot number and shows the validation dig location in relation to the plot.

Photograph 2 – Shows the validation depth clearly, using a staff and a marker which crosses the hole. Shows the topsoil and subsoil, and the base of the hole.

Photograph 3 – Shows the validation hole in context. The plot being validated can be seen, along with nearby plots.

The validation should be written up into a Verification Log, shown below:

		Verification Log
Project Name:		
Project Number:		
Location:		
Client:		
Remediation Requirements:		
Validation Requirements:		
Plot Number:		
Grid reference:		
Inspection date:		
Engineer:		
Photographs:		
Photographs shows		
This plot has PASSED / FAILED* verification (<i>delete as appropriate</i>)		
*Proposed further remedial works (if FAILED):		
An additional inspection IS / IS NOT required for this plot (<i>delete as appropriate</i>)		

ACCEPTABILITY CRITERIA FOR GENERAL FILL

Determinand (mg/kg unless stated)	Acceptability Criteria for General Fill
Asbestos (%)	<0.001 – 0.01%
pH	>5 - <10 ⁽³⁾
Total Cyanide	0.5 ⁽³⁾
Free Cyanide	0.5 ⁽³⁾
Soluble Sulphate (mg/l)	500 ⁽³⁾
Arsenic	640
Beryllium	12
Boron	240000
Cadmium	190
Chromium (III)	8600
Chromium (VI)	33
Copper	68000
Lead	2330 ⁽¹⁾
Inorganic Mercury	1100
Nickel	980
Selenium	12000
Vanadium	9000
Zinc	730000
Total PAHs	1000 ⁽⁴⁾
TPH > EC6 - EC40	5000 ⁽⁴⁾

LQM/CIEH S4ULs for Human Health Risk Assessment (3rd edition, 2015) used unless stated:

- 1) Category 4 Screening Levels (March 2014)
 - 2) CL:AIRE Soil GAC for Human Health Assessment (January 2010)
 - 3) In-house screening criteria used as no GAC methodology currently exists
 - 4) Hazardous waste thresholds. This limit only applies to imported material, not to in-situ soil.
- Assumed 1% SOM (most conservative) for those values dependent upon SOM.*

APPENDIX 3



VERIFICATION REQUIREMENTS FOR COVER SYSTEMS

Technical Guidance for
Developers,
Landowners and
Consultants



**Yorkshire and Lincolnshire
Pollution Advisory Group**

Version 4.1 – June 2021

The purpose of this guidance is to promote consistency and good practice for development on land affected by contamination. The Local Authorities in Yorkshire, Lincolnshire, the North East of England, East Anglia, Greater Manchester and St Helens who have adopted this guidance are shown below:



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Disclaimer

This guidance is intended to serve as an informative and helpful source of advice. YALPAG will review this guidance every three years, but readers must note that legislation, guidance and practical methods are inevitably subject to change and therefore should be aware of current UK policy and best practice. This note should be read in conjunction with prevailing legislation and guidance, as amended, whether mentioned here or not. Where legislation and documents are summarised this is for general advice and convenience, and must not be relied upon as a comprehensive or authoritative interpretation. Ultimately it is the responsibility of the person/company involved in the development or assessment of land to apply up-to-date working practices to determine the contamination status of a site and the remediation and verification requirements.

Acknowledgments

YALPAG would like to thank North Lincolnshire Council, Leeds City Council, City of Bradford Metropolitan District Council, Barnsley Metropolitan Borough Council, Rotherham Metropolitan Borough Council, Wakefield Council, and Tameside Metropolitan Borough Council, for producing this guidance.

YALPAG would also like to acknowledge Liverpool City Council's Contaminated Land Team, Coopers Consulting Engineers for allowing us to use their guidance document and photographs and WSP Environmental Ltd for also donating photographs.

Consultation

39 Local Authorities and 6 Environmental Consultants were consulted over a four week period in 2010 during the production of the initial guidance. At that time, consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

49 Local Authorities and 25 Environmental Consultants were consulted in 2021, during the production of this version [4.1] of the guidance. Consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

Introduction

This guidance has been produced to help developers ensure that they can demonstrate that material brought onto a development site for gardens or areas of soft landscaping are suitable for use and do not present harm to people, the environment and/or property. It is intended to improve the quality of reports submitted to Local Authorities on this matter and to give contractors/consultants a point of reference to obtain approval for such work from their client. This guidance does not cover the geotechnical suitability of soils or materials, chemical suitability that does not affect human health e.g. sulphates, or importing soils contaminated with invasive (or injurious) plants.

The verification of cover systems should be an integral part of the remediation project and agreed between developers and regulators at an early stage in the project.

UK guidelines for remediation verification are set out within Land Contamination Risk Management¹ (LCRM) and the document on Verification of Remediation of Land Contamination². This guidance note should be considered as supplementary advice in conjunction with these documents.

This guidance relates to the remediation of land contamination by using cover systems; however, the verification of the quality of imported material is equally important in other situations, such as raising levels for flood prevention or general landscaping works. This guidance could also be used in such instances.

The Process of Verification

Implementation plans for remedial works should always be site specific. Where a cover system and potentially, excavation, is the main remedial method or a component of an overall site remediation, specific goals will need to be set that are linked directly to the risk management strategy for the site in question.

For cover and containment systems, verification will normally depend upon the provision of defensible measurements, observations and records. Critical factors to be considered are:

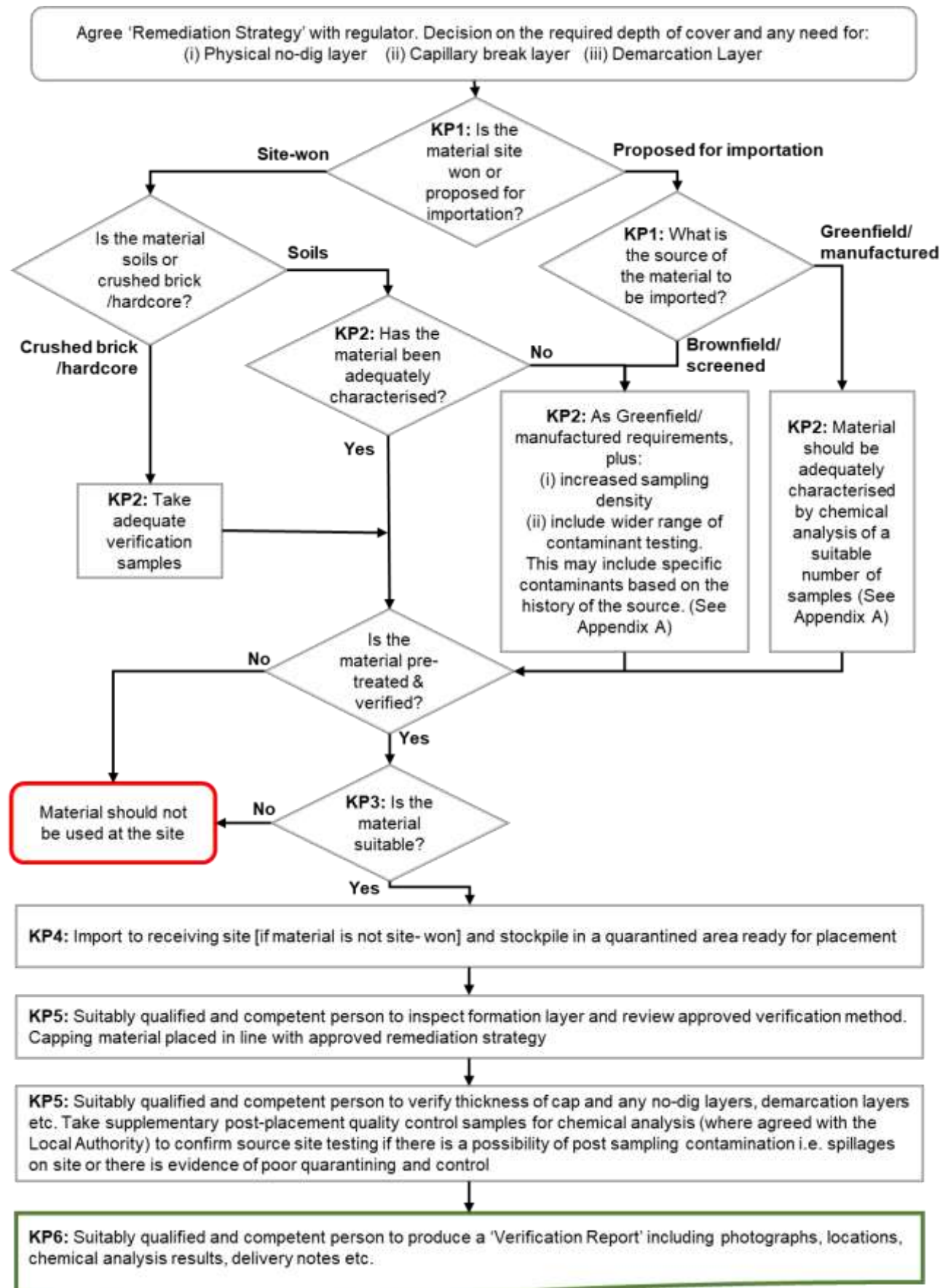
- What should be measured?
- When should they be measured?
- Where measurements need to be taken, what is the appropriate monitoring regime i.e. number and frequency of samples?
- Statistical constraints on sampling.

National Planning Policy Framework (NPPF) states that “planning policies and decisions should ensure that after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990”. The Verification Report is a key document to demonstrate compliance with NPPF, and the responsibility rests with the developer/applicant to submit the required Verification Report to complete the remediation and to discharge any planning conditions.

¹ Land Contamination Risk Management, Environment Agency, Oct 2020

² Verification of Remediation of Land Contamination. Environment Agency, Feb 2010

Overview Flowchart



Key Points

KP1: Source of Material

Material can be sourced from site won material i.e. crushed brick/hardcore or site-won soils from existing open or landscaped areas. In the interest of sustainability, Local Authorities promote the use of such site-won material providing that they are suitable for the intended end use of the site.

Alternatively, material can be sourced from other developments and commercial companies. Dependent on the source of the material it can be classified as either from a 'Greenfield/Manufactured' or 'Brownfield/Screened' source.

Broadly speaking material can be classified as follows:

Greenfield – Where documentary evidence is provided confirming that the source site has not been developed and that no past contaminative uses have occurred. Should evidence not be provided or approved by the Local Authority, please note that the source would be expected to be assessed as though it were a brownfield source.

Manufactured – from a commercial company who manufacture material by mixing or blending mineral soils (subsoil or sand) with an organic amendment (compost). If other soil component sources are used, documentary evidence should be provided confirming that the source site has not been developed and that no past contaminative uses have occurred. Should documentary evidence not be provided or approved by the Local Authority, please note that the source would be expected to be assessed as though it were a brownfield source.

Brownfield – material from a donor site that has previously been developed

Screened – material from a company who deal with skip/demolition waste which is screened for unsuitable material i.e. bricks, wood, plastic etc.

KP2: Characterisation of Material

It is essential that material is suitable for its intended use. Documentary evidence of the source of the material should be provided to the Local Authority. This may include desk study or site investigation reports. A defensible method is required to ensure the verification proposals are site specific and that the level of sampling reflects the need to ensure that imported material are suitable for their intended use.

Due to the diminishing supply of suitable Greenfield topsoil sources it has been found that the chemical quality of Greenfield sources is less reliable in certain areas. As a result the recommended analytical rate for the intended use of the development may vary between Local Authorities [see **Appendix 1a**].

When should this be done?

Sampling of material should be undertaken as early as possible i.e. prior to placement [for site won material] and prior to importation [for imported material]. This is to avoid the costly exercise of re-excavating unsuitable material and the possibility of cross contamination. Where the assessor has confidence that the material is of sufficient quality (i.e. tested by supplier, used previously) it is acceptable to test the material on site. Although, if it is deemed unsuitable it would have to be either removed off site or pre-treated at the cost and time of the developer. It is recommended that some verification samples are also taken once this material has been delivered to site to confirm suitability for use. Soils can become contaminated during transportation or when stockpiled on site.

What about certificates from commercial suppliers?

Where the material is provided by a commercial company, certificates or other industry Quality Protocol compliance i.e. WRAP, DoWCoP, will normally be accepted. This is on the proviso that it: (i) relates to the actual material being imported to the site and the type and amount of analysis is in line with what is prescribed in Appendix 1a; and, (ii) the certificates are less than two months old.

It is recommended that some additional verification samples are taken once this material has been delivered to site. Soils can become contaminated during transportation or when stockpiled on site.

Extreme caution should be given to importing material that has been recycled from demolition or skip waste as they could easily be contaminated e.g. asbestos containing materials. Please refer to “questions you should be asking your supplier” in **Appendix 1b** and include the responses in your report.

British Standard

Imported soils should be as specified in BS 3882:2015 for topsoil and BS8601:2013 for subsoil as ‘suitable for their intended purpose’. Both British Standards relate mostly to nutrient content of topsoil and phytotoxic contamination and they do not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to those specified in the relevant British Standards to ensure that they are suitable for their intended use.

Initial screening

A visual / olfactory inspection of the material should be carried out by a suitably qualified and competent person to ensure that:

- It is a suitable growing medium;
- It is free from obvious contamination i.e. staining/free product etc.;
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants, as specified by the Environment Agency, are suspected to have been growing;
- It is not odorous (could be considered a statutory nuisance);
- It is free from unsuitable material i.e. bricks, brick ties, timber and glass etc.); and,
- There are no visible signs of asbestos containing material (ACMs).

Testing schedule & number of samples

Chemical testing will normally be required on any materials that are to be used as cover material, even where this includes first generation quarried material. This should be carried out by a suitably qualified and competent person.

Appendix 1a explains in detail the sampling and testing requirements for a typical residential development. These are only guidelines and it may be necessary to deviate away from them depending on local and site-specific factors. It is recommended that the developer discusses any deviation with the Local Authority.

The following criteria sets out the requirements for sampling and testing:

- **Virgin Quarried Material** sampling needs to be 1 or 2 samples depending on the type of stone utilised, to confirm the inert nature of the material. Testing to include standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn).
- **Crushed Hardcore, Stone, Brick (excluding asphalt)** a minimum of 1 sample per 500m³. Testing to include standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH. Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).
- **Greenfield/ Manufactured Soils** a minimum of 3 samples or, dependent on source and receptor, between 1 per 50m³ and 1 per 250m³. Testing to include standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)).
- **Brownfield/ Screened Soils** a minimum of 6 samples or dependent on source and receptor, between 1 per 50m³ and 1 per 100m³. Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC). Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).

The assessment criteria need to be UK based, e.g. LQM S4ULs, Defra C4SLs or other similarly derived GACs.

KP3: Suitability of Material

Based on the characterisation of material above, the material should be either deemed suitable or unsuitable. Obviously unsuitable material should not be used (unless it is treated to reduce levels of contaminants below agreed target levels i.e. bioremediation – this would have to be agreed and included within the Remediation Strategy) and an alternative source of material should be sought by the developer. If the material is considered suitable it can be imported (if not site won) and stockpiled in a suitably quarantined area [refer to **KP4**].

KP4: Stockpiling & Quarantining of Material

It is essential that the 'suitable' material is either placed in its intended area straight away i.e. soft/landscaped areas or stockpiled in a suitable quarantine area to prevent on-site contamination.

In the event that an assessor finds material has been stored in an unsuitable area, samples should be taken to confirm that no cross contamination has occurred (including a visual/olfactory check of the material). The material should then be suitably quarantined or placed at its intended location immediately.

KP5: Verification of Required Depth

In line with the agreed Remediation Strategy, it is important to establish that the required depth has been achieved and is consistent across the site. There are two main ways to achieve this:

Depth testing in situ – small trial pit excavated to allow measurement of its depth by standardised tape measure or measuring staff.

Topographical surveys – accurate survey of the base and final formation layer height to establish the depth of cover.

Specific Local Authority Policy

Please check with the local Contaminated Land Officer to establish:

- Which type of method for testing depth is accepted; and,
- The number of verification areas per property, plot, landscaped area or garden area (some Local Authorities recommend at least 2 per plot for residential developments).

Important Note: Where demarcation, physical no-dig and capillary break layers exist they should be verified for their thickness and presence during the time of their installation. Details of the demarcation layer should be agreed with the Contaminated Land Officer prior to placement. This will include the design, type and strength of the geotextile separator or visual warning membrane. The verification of depth and confirmation of such layers should be carried out by a suitably qualified and competent person.

KP6: Reporting

The purpose of verification documentation is to provide transparent reasoning why the remediation was required, a methodology about how it was to be undertaken and proof that the specified works have been undertaken and to provide confirmation that the site is “suitable for its intended use”.

The document is utilised not only to satisfy conditions of planning permissions but also is to be kept on record by the Local Authority should queries be raised during the lifetime of the development and to confirm to future purchasers that the site is suitable for use.

National Planning Policy Framework (NPPF) states that “planning policies and decisions should ensure that after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990”. The Verification Report is a key document to demonstrate compliance with NPPF, and the responsibility rests with the developer/applicant to submit the required Verification Report to complete the remediation and to discharge any planning conditions.

It is also essential that other supporting documentation is included within a report carried out by a suitably qualified and competent person e.g. laboratory analysis results, delivery tickets for material, certificates for imported material (or if unavailable, documented evidence of the source of the Greenfield material), trial pit logs etc. A checklist has been included in **Appendix 2** to give an idea on what information should be recorded.

Additionally, any reporting should include details of any measures required to maintain the cover system integrity in the future e.g. successive construction phases (management plans) and longer term (restrictive covenants on title deeds).

Photographic evidence for validating the depth of cover

The Local Authority ideally would recommend the following programme of photographs to be taken of the placement of inert cover:

- Photographs of any stockpiles and quarantine areas
- Proof that the depth of inert cover has been installed
- Proof of the quality of the material to be used as inert cover
- Proof there is a geotextile separator and visual warning membranes if used between the underlying material and suitable for use soils.
- Proof of the method of placement and different layers if appropriate
- Proof of the completed project
- Inclusion of background features which will aid locating the photograph
- Inclusion of site identification boards within the photos which show the date, position taken i.e. corner of plot 3 and the site name.
- Inclusion of photographs of site stockpiles and quarantine areas.

The presence of good quality photographs is essential to prove beyond doubt that the remediation has been done as specified both by method and position, and that the images have been taken from the specific area stated.

Refer to **Appendix 3** for examples of good photographic evidence.

Appendix 1a – Sampling & Testing Matrix

Type	Number of Samples	Testing Schedule	Assessment Criteria
Please note that these guidelines apply to a typical residential development, and relaxation of the guidelines or more stringent requirements may apply dependent on local and site specific factors. Therefore, <u>all parameters need to be agreed with the Local Authority.</u>			
Virgin Quarried Material	1 or 2 depending on the type of stone utilised, to confirm the inert nature of the material.	Standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn)	The assessment criteria need to be UK based, e.g. LQM S4ULs, Defra C4SLs or other similarly derived GACs.
Crushed Hardcore, Stone, Brick (excluding asphalt)	Minimum 1 per 500m ³	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH. Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).	
Greenfield/ Manufactured Soils	Minimum 3 Dependent on source and receptor, between 1 per 50m ³ and 1 per 250m ³	Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)).	
Brownfield/ Screened Soils	Minimum 6 Dependent on source and receptor, between 1 per 50m ³ and 1 per 100m ³	Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC). Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).	

Appendix 1b – Questions to Ask Your Soil Supplier Relating to Soil Quality

- What is the source of the material (refer to KP1)? If the source is Greenfield, can they provide evidence of this?
- Will all of the material be coming from the same source?
- Are you satisfied that the material is a suitable growing medium for the proposed end use?
- Has the supplier used an appropriate sampling protocol to ensure a representative sample is analysed? What volume of soil is represented by the analysis and does it comply with Appendix 1a?
- Does the testing include analysis of contaminants identified in Appendix 1a?
- Does the laboratory conducting the analysis have UKAS and MCERTS accreditation for the tests they are carrying out?
- Does the material comply with relevant waste regulations?
- Can I have a copy of the whole analysts report and does it include an interpretive section?
- Will the provided certificate be dated within the last 2 months?

Appendix 2 – Checklist for Verification Reports

Example only. Not to be considered as typical minimum requirements. Additional information should be included for non-cover systems aspects of the remediation i.e. gas protection measures etc.

Site Details	
Site Name / location	
Developer name	
Development use	
Plot No / description of landscaped area (inc plan of inspection areas)	
National Grid Reference	
Inspection visit date	
Supporting Evidence	
Description of remediation (as per agreed Remediation Method Statement including depths / thickness checks, topographical readings)	
Material tracking information (including way tickets etc.)	
Name of groundwork's remediation contractor	
Name of supervising environmental consultant	
Site Specific chemical analysis results	
Verification Photographs (inc. remarks)	
Recommendations	
Pass/fail	
If material fails, how will this be managed i.e. removed, treated	
Detail any further remedial works and/or inspection	
Signed off	

Failure to provide any of the above information may prevent planning conditions from being discharged.

Appendix 3 – Examples of Good Quality Photographs



© Coopers
Consulting
Engineers

Photograph 1:
Depth check of inert
cover within area of
public open space.
Physical break layer
and topsoil visible.



© WSP

Photograph 2:
Depth check of inert
cover with Site &
Location Information
Board.



© **Coopers Consulting Engineers**

Photograph 3:
Depth check of inert cover within areas of front gardens.



© **Coopers Consulting Engineers**

Photograph 4:
Depth check of inert cover within areas of front gardens.



© **Coopers Consulting Engineers**

Photograph 5:
Depth check of inert cover within rear gardens. Taut string line spans across excavation.



© **Coopers
Consulting
Engineers**

Photograph 6:
Depth check of inert
cover within rear
gardens. Taut string
line spans across
excavation.



© **Coopers
Consulting
Engineers**

Photograph 7:
Shows the spatial
location of the
verification pit.



© **Coopers Consulting Engineers**

Photograph 8:
Excavation within public open space and verification pit showing the presence of a remediation break layer at the base, a crushed sandstone inert fill overlain by topsoil.



© **Coopers Consulting Engineers**

Photograph 9:
Inert crushed sandstone being delivered. The spatial area of the remediation can be observed from these photographs (old terrace housing).



© **Coopers Consulting Engineers**

Photograph 10: Inert crushed sandstone being delivered with visible remediation break layer. The spatial area of the remediation can be observed from these photographs (traffic lights).



© **Coopers Consulting Engineers**

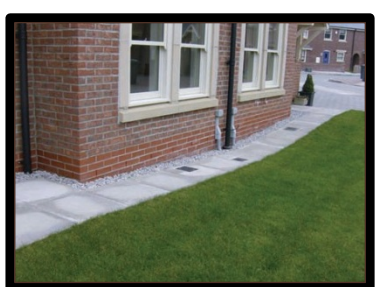
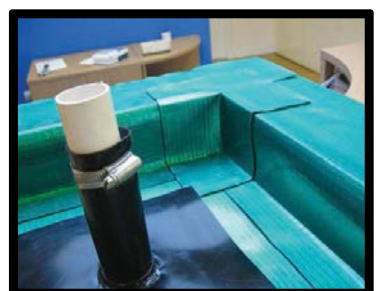
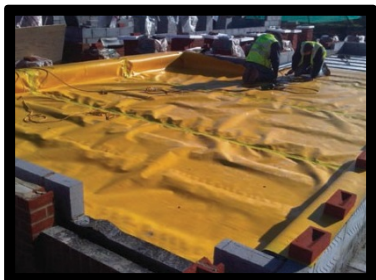
Photograph 11:
Shows the remediation of the rear garden, with a significant depth (1.0m) of inert cover. This photograph has been stitched to form a panoramic photograph and hence there is slight distortion



© **Coopers Consulting Engineers**

Photograph 12:
Shows the remediation of the rear garden, with a significant depth (1.0m) of inert cover. Remediation break layer visible at the base of the excavation.

APPENDIX 4



VERIFICATION REQUIREMENTS FOR GAS PROTECTION SYSTEMS

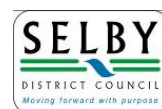
Technical Guidance for
Developers,
Landowners and
Consultants



Yorkshire and Lincolnshire
Pollution Advisory Group

Version 1.1 – December 2016

The purpose of this guidance is to promote consistency and good practice for development on land affected by contamination. The Local Planning Authorities in Yorkshire, Lincolnshire and the North East of England who have adopted this guidance are shown below:



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Disclaimer

This guidance is intended to serve as an informative and helpful source of advice. It is intended to review this guidance annually, but readers must note that legislation, guidance and practical methods are inevitably subject to change and therefore should be aware of current UK policy and best practice. This note should be read in conjunction with prevailing legislation and guidance, as amended, whether mentioned here or not. Where legislation and documents are summarised this is for general advice and convenience, and must not be relied upon as a comprehensive or authoritative interpretation. Ultimately it is the responsibility of the person/company involved in the verification of land contamination to apply up-to-date working practices and requirements.

Acknowledgments

The authors and YALPAG would like to specifically acknowledge and thank CIRIA for the permission to use sections, including tables and photographs, of the CIRIA C735 document. Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) *Good practice on the testing and verification of protection systems for buildings against hazardous ground gases*, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

The author, Leeds City Council (Brad Hall, Julia Reynolds), would like to acknowledge the assistance provided by the following people and organisations: East Riding of Yorkshire Council, Doncaster Metropolitan Borough Council, Wakefield Council, Hugh Mallett of BuroHappold, Neil Salvage of PAGEotechnical and John Naylor of Ground-Gas Solutions.

Consultation

The YALPAG Local Planning Authorities were consulted over a four week period in 2015 during the production of this guidance. Consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

Introduction

This guidance has been produced to help developers ensure that they can demonstrate that gas protection systems are appropriate for the development and level of risk associated with a site and that they have been installed correctly and can be relied upon to provide the required level of protection and ultimately demonstrate that, in terms of gas risk, the development is suitable for use. It is intended to improve the quality of reports submitted to Local Planning Authorities on this matter and to give contractors/consultants a point of reference to obtain approval for such work from their client.

The verification of gas protection systems should be an integral part of remediation and agreed between developers and Local Planning Authorities at an early stage in the development.

Failure to comply with this guidance may result in delays to the development. Relevant planning conditions cannot be discharged until the Local Planning Authority is satisfied appropriate verification has been undertaken to confirm that the development is safe.

Available UK guidance regarding gas risk assessment includes:

- CIRIA C665 Assessing risks posed by hazardous ground gases to buildings;
- NHBC Report Edition No: 4 Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present;
- BS 8485:2015 Code of practice for the design of proactive measures for methane and carbon dioxide ground gases for new buildings.

In particular, readers of this document should refer to the detailed guidance on verification published by CIRIA (CIRIA C735 Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases, 2014). This guidance note should be considered as supplementary advice to be used in conjunction with these documents.

This document does not cover risks associated with radon. Please contact individual Local Planning Authority for further information.

The following YALPAG technical guidance documents for developers, landowners and consultants are also available;

- Verification Requirements for Cover Systems.
- Development on Land Affected by Contamination.

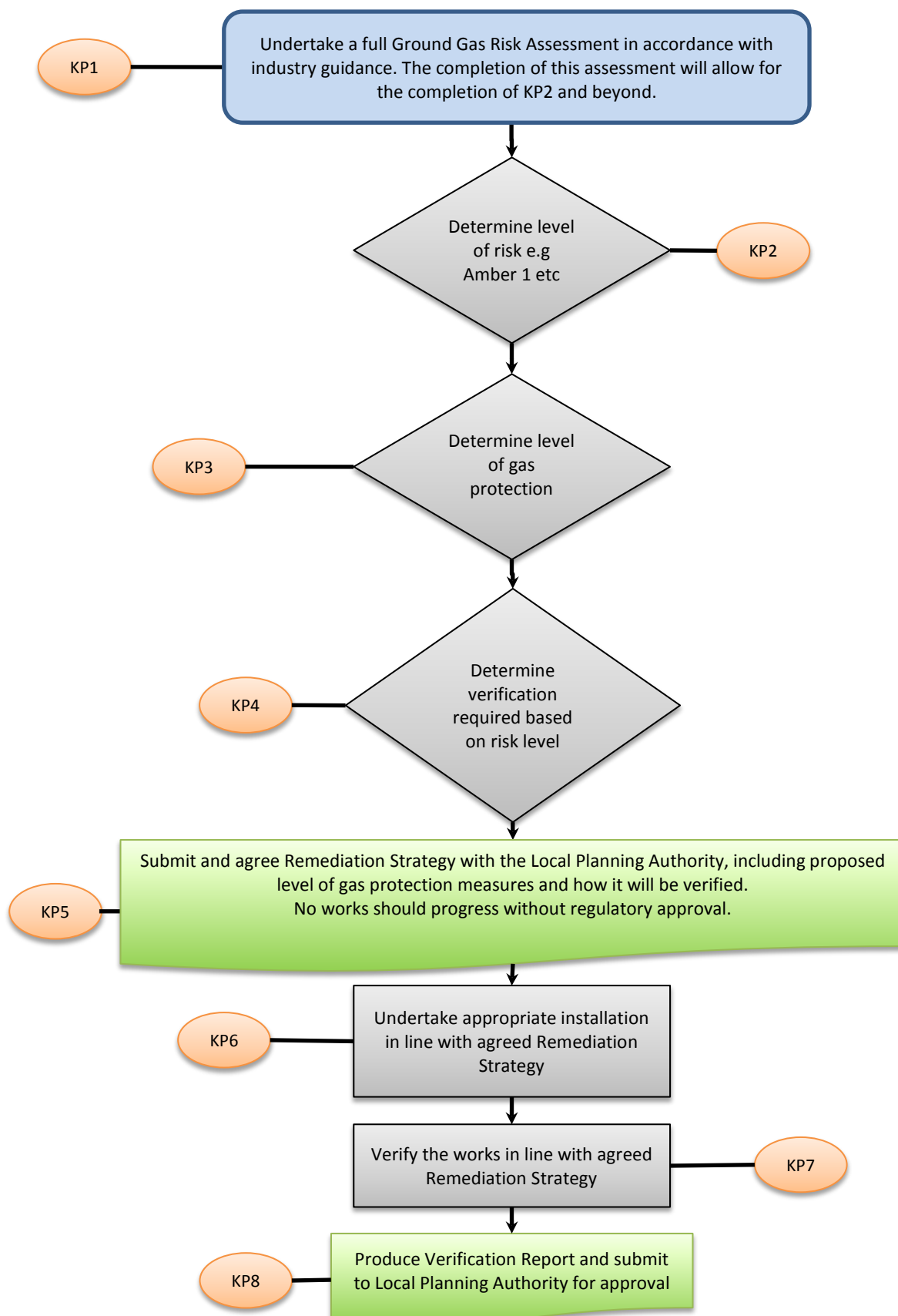
The Process of Verification

Implementation and verification plans for gas protection systems should always be site specific and based on the gas risk assessment and conceptual site model (CSM) for the site in question.

For gas protection systems, acceptable verification will normally comprise the provision of clear evidence that the level of protection is appropriate to the established risk and has been installed by suitably experienced personnel in line with the manufacturer's instructions and appropriate guidance. Critical factors to be considered are:

- What should be installed?
- How should it be installed?
- Who should install it?
- How will correct installation be demonstrated?

Overview Flowchart



Key Points

KP1 Ground Gas Risk Assessment	Undertake an appropriate gas risk assessment for the site in accordance with industry guidance*. On completion of the risk assessment and the generation of the appropriate Gas Screening Value (where required) and on a full understanding of the gas regime/ CSM, move to KP2 to determine the level of risk for the site. <i>*Where the desk study has identified the need for gas monitoring to be carried out it would always be expected that site specific gas monitoring data would be used in the gas risk assessment.</i>
KP2 Level of Risk	The level of gas risk needs to be determined by using the appropriate gas guidance document/s relative to the development (e.g. low rise housing, residential apartment blocks with areas of public open space, commercial or public buildings etc). For example Amber 1 (Low rise housing) equates to Low Risk in Table A1 CIRIA 735. Once the level of risk has been determined move to KP3 and determine the appropriate level of gas protection.
KP3 Level of Gas Protection	The level of gas protection should be based on the level of risk established by the gas risk assessment and CSM. It should provide the appropriate gas protection for the <i>lifetime of the development</i>. Detailed specification of gas protection measures in accordance with appropriate guidance to include (but not be limited to): • Submission of appropriate drawings (site specific plans and details to clearly show where the measures will be installed and how they fit into the design of the building and foundations). • Full written description of the protection measures to be included. • Detailed justification of the protection measures being used along with reference to the guidance document(s) being used.
KP4 Level of Verification Required	The level of qualification and experience of the installer will determine the level of verification required. Verification should always be carried out by an appropriate independent person such as an experienced and suitably trained verification consultant or third party qualified and experienced installer (see KP6). See Appendix 1 for full details of verification requirements for installation of gas protection measures and the associated verification requirements.

KP5 Submission and Agreement of Remediation Strategy	No installation of gas protection measures should be carried out at the site until the full details (KP1 to KP4) have been approved by the Local Planning Authority and formalised in an agreed Remediation Strategy (including Verification Plan). The Remediation Strategy, incorporating the detailed Verification Plan, should include (but not be limited to): • A summary of the ground gas risk assessment. • The gas protection measures proposed. • Who will undertake the installation including levels of experience and/ or qualifications. • How the works will be verified/ tested and by who. • How the works will be reported to the Local Planning Authority. See Appendix 2 for details of Remediation Strategy requirements.
KP6 Installation of Gas Protection	Installation should only be done once the Remediation Strategy has been agreed with the Local Planning Authority and should be carried out in line with the agreed Remediation Strategy. Any deviation away from the agreed Remediation Strategy should be agreed in writing with the Local Planning Authority prior to commencement of installation. See Appendix 4 for examples of good and poor gas protection installation.
KP7 Verification of Gas Protection	The verification of the gas protection measures should be undertaken in accordance with the Verification Plan set out in the agreed Remediation Strategy. Any deviation to works away from the agreed Remediation Strategy should be agreed in writing with the Local Planning Authority prior to installation. See Appendix 5 for an example Verification proforma.
KP8 Submission of Verification Report	The Verification Report must be produced in line with the agreed Remediation Strategy and Verification Plan. All aspects of the Remediation Strategy must be addressed in the Verification Report along with full details and justification of any deviation. See Appendix 3 for details of the required contents of the Verification Report. Please note, the required contents should be agreed within the submitted and approved Remediation Strategy at KP 5.

Appendix 1 – Requirement for Installation and Verification

Copied directly from Annex 1 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

The tables in this appendix should be used for guidance only and are not intended to be used in lieu of sound professional judgment, which should take into account the risk factors affecting the development (the gas regime, the number of buildings, the complexity of design, and the expertise of the installation workforce) on a site-specific basis. The tables should not be used independent of, and without reference to, the accompanying text in the main guide C735.

Situation A – all development types except situation B – non reinforced slabs (from Wilson et al, 2007)

Gas regime/risk	Slab type	Installer experience	Suggested levels of verification and integrity testing
Low risk CS2 (*with venting) Basic radon protection area	Non reinforced All slabs	General builder/groundworker/landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to all concrete pours. Contractor to supply sign off sheets (verification evidence) including photographs to independent verifier.
		Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer) to conduct a thorough verification (visual) inspection prior to 25 to 50 per cent of concrete pours (min one visit). Installer to supply sign off sheets (verification evidence) including photographs to independent verifier for all other pours.
Intermediate risk CS2 (no venting) or CS3 (*with venting) Full radon protection area		General builder/groundworker/landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to all concrete pours. All joints, pipe penetrations etc independently air lanced to ASTM D4437. Contractor to supply sign off sheets (verification evidence) including photographs to verifier. Consideration given to need for/scope of integrity testing (eg initially on say 25 to 50 per cent of pours then falling to 10 to 25 per cent if acceptable results obtained and no concerns raised by visual inspections).
Gas regime/risk	Slab type	Installer experience	Suggested levels of verification and integrity testing
Intermediate risk CS2 (no venting) or CS3 (*with venting) Full radon protection area	Non reinforced All slabs	Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to 25 to 50 per cent of concrete pours (min two visits). 25 per cent all joints, pipe penetrations etc independently air lanced to ASTM D 4437. Remaining 75 per cent joints, pipe penetrations etc tested to recognised standard by installer (as detailed in method statement/CQA plan). Installer to supply sign off sheets (verification evidence) to verifier for all other pours. Consideration given to need for/scope of integrity testing (eg initially on 10 to 25 per cent of pours then falling to 0 to 10 per cent if acceptable results obtained and no concerns raised by visual inspections).
High risk VOCs etc CS3 (no venting) or CS4 and above (*with venting)		Qualified ¹ and experienced installer (50 per cent of operatives to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to all concrete pours. All joints, pipe penetrations independently air lanced to ASTM D 4437. Installer to supply sign off sheets (verification evidence) to verifier for all pours. Consideration given to need for scope of integrity testing (eg initially on 25 to 50 per cent of pours then falling to 10 to 25 per cent if acceptable results obtained and no concerns raised by visual inspections).

Notes

* Assumes venting designed to keep steady state concentration of CH₄ below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate

- 1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).
- 2 Before works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.
- 3 Consideration should be given to carrying out leak detection (ie smoke, tracer gas or dielectric testing) on the first plots on higher end sites CS3 and above. If an unacceptable amount of holes are found during these tests then the verification consultant should discuss with the relevant personnel, strategies to prevent this occurring, these could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.
- 4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.
- 5 Air lancing is the only integrity test that has an independently recognised international standard that is suitable for testing taped and welded seams.

Situation A – all development types except situation B – reinforced slabs (from Wilson et al, 2007)

Gas regime/risk	Slab type	Installer experience	Suggested levels of verification and integrity testing
Low risk CS2 (*with venting) Basic radon protection area	Reinforced All slabs	General builder/ groundworker/ landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to all concrete pours. Contractor to supply sign off sheets (verification evidence) including sub grade acceptance forms and photographs to independent verifier.
		Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to 25 per cent concrete pours (min two visits), including vented void, subgrade etc. Installer to supply sign off sheets (verification evidence) including, sub grade acceptance forms, photographs to independent verifier for all other pours.
Intermediate risk CS2 (no venting) or CS3 (*with venting) Full radon protection area		General builder/ groundworker/ landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to all concrete pours including vented void, subgrade etc. All joints, pipe penetrations etc independently air lanced to ASTM D4437. Consideration given to the need for and scope of integrity testing (eg initially on say 50 to 25 per cent of pours then falling to 25 to 10 per cent if acceptable results obtained and no concerns raised by visual inspections).
		Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct a thorough verification (visual) inspection prior to 50 per cent of concrete pours, including vented void, subgrade etc 25 per cent of joints, pipe penetrations etc independently air lanced to ASTM D4437. Remaining joints, pipe penetrations, corners etc tested to a recognised standard by installer (as detailed in method statement and CQA plan). Installer to supply sign off sheets (verification evidence) including, sub grade acceptance forms, photographs etc to independent verifier for all other pours. Consideration given to need for/scope of integrity testing (eg initially on 10 to 25 per cent of pours then falling to 0 to 10 per cent if acceptable results and no concerns raised by visual inspections).
			High risk VOC and hydrocarbons CS3 (no venting) or CS4 and above (*with venting)

Notes

- * Assumes venting designed to keep steady state concentration of CH₄ below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate.
- 1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).
 - 2 Before works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.
 - 3 Consideration should be given to carrying out leak detection (ie smoke, tracer gas or dielectric testing) on the first plots on higher end sites CS3 and above. If an unacceptable amount of holes are found during these tests then the verifier should discuss with the relevant personnel, strategies to prevent this occurring, these could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.
 - 4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.
 - 5 Air lancing is the only integrity test that has an independently recognised international standard that is suitable for testing taped and welded seams.

- 6 Where a sufficiently robust protection layer (protection fleece, protection boards or insulation) are laid directly on the membrane, inspection after placement of the reinforcement should not be necessary.

Situation B – low rise housing with ventilated void (from NHBC and Wilson et al, 2007)

Gas regime/risk	Slab type	Installer experience	Suggested levels of verification and integrity testing
Low risk Amber 1	All slabs with min 150 mm ventilated sub floor void	General builder/ groundworker/ landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct thorough verification (visual) inspection of first plot and after placement of reinforcement if no protection provided. Subsequent inspections carried out at approx. frequency of 1 in 10 plots (minimum 5). Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing if concerns identified by visual inspections ³ .
		Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct thorough verification (visual) inspection of first plot and after placement of reinforcement if no protection provided. Subsequent inspections carried out at approx. frequency of 1 in 20 plots. Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing if concerns identified by visual inspections ³ .
Intermediate risk Amber 2		General builder/ groundworker/ landfill operative (no relevant qualification ¹)	Verifier (consultant ⁴ or qualified and experienced installer ¹) to conduct thorough verification (visual) inspection of first 10 plots and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Subsequent inspections (including air lancing) carried out at approx. frequency of 1 in 20 plots Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing (eg initially on 30 to 50 per cent of plots then falling to 0 to 10 per cent of plots if acceptable results obtained and no concerns raised by visual inspections).
		Qualified ¹ and experienced installer (minimum one operative to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct thorough verification (visual) inspection of the first 5 plots and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Subsequent inspections (including air lancing) carried out at a frequency of about 1 in 20 plots. Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing (eg initially on 10 to 25 per cent of plots then falling to 0 5 per cent of plots if acceptable results obtained and no concerns raised by visual inspections) ³ .
High risk Red VOC and hydrocarbons		Qualified ¹ and experienced installer (all operatives to hold qualification)	Verifier (consultant ⁴ or third party qualified and experienced installer ¹) to conduct thorough verification (visual) inspection of all plots, and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Consideration given to need for/scope of integrity testing (eg initially on 30 to 50 per cent of plots then falling to 0 to 10 per cent of plots if acceptable results obtained and no concerns raised by visual inspections) ³ .

Notes

- * Gas regime defined by characteristic situation as set out by Wilson et al (2007), and all other recent good practice guidance and British Standards.
- ** Assumes venting designed to keep steady state concentration of CH₄ below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate.
- 1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).
- 2 Before the works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.
- 3 Consideration should be given to carrying out integrity testing/leak detection (ie smoke, tracer gas or dielectric testing) on the above basis and/or if an unacceptable amount of damage/loss of integrity is found during visual inspections. In this instance the consultant should discuss with the relevant personnel, strategies to prevent this recurring. This could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.
- 4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.
- 5 Air lancing is the only integrity test that has an independently recognised international standard suitable for testing taped and welded seams and should be used at the frequency suggested in the table.

Appendix 2 – Remediation Strategy and Verification Plan for Gas Protection Systems

The Remediation Strategy should include a detailed verification method statement. This should address how the gas protection measures will be installed and what verification information will be provided to demonstrate the installation has been carried out in accordance with the appropriate guidance.

As a minimum the report should include (but not be limited to):

- A summary of the gas risk assessment.
- The gas protection measures proposed (including reference to the appropriate guidance documents) and confirmation they will meet the gas protection requirements for the lifetime of the development.
- Technical drawings showing how the gas protection measures will be incorporated.
- Formal qualifications/experience/training of the person carrying out the installation.
- Formal qualifications/experience/training of the person carrying out the verification.
- Clear demonstration of the independence of the person carrying out the verification.
- The manufacturer's specification of the gas protection membrane to be used.
- Full details of what the verification process will comprise and at what stage verification will be carried out.
- Details of how any non-conformance will be dealt with.
- Details of the number of plots to be validated. (Deviation from verification of every plot will need to be justified and agreed with the Local Planning Authority in line with Appendix 1 of this document).
- Timeline of when during the build, each of the gas protection measures will be installed.
- Details of management measures proposed to ensure how damage to the membrane will be prevented prior to the floor being installed, post installation.
- Details of how all site personnel (including follow on trades) will be made aware of the presence of the membrane and that damage to the membrane must be prevented.
- Details of the extent of overlap and method of sealing (these must be in line with manufacturer's instructions and evidence provided).
- Confirmation that a signed (plot specific unless agreed otherwise) statement confirming that the gas protection measures were installed as agreed and that the membrane was free from tears and punctures and was lapped and sealed as agreed at joins and around services and sub floor voids were clear and free from debris will be included in the Verification Report.
- Confirmation that plot specific photographs showing the installed membrane will be included in the Verification Report.

Appendix 3 – Checklist for Gas Verification Reports

The Verification Report should include a summary of all the works undertaken, relating to gas protection measures including all elements detailed within the Remediation Strategy.

As a minimum the report should include (but not be limited to):

- Site details.
- Planning Application details.
- Summary of Gas Risk Assessment (including original CSM).
- Details of who carried out installation (qualifications/experience/training).
- Details of who carried out verification (qualifications/experience/training).
- Description of protection measures installed with reference to method statements and drawings and manufacturers specification of the materials used.
- Details of the verification inspection regime.
- Supporting information, plans, air vent installation, photographs, as built drawings.
- Summary of verification data (completed proformas, test results)
- Details of non-conformances and how they were rectified.
- Clear statement saying remedial objectives been achieved supported by lines of evidence including reference to CSM.
- Where necessary further works and/ or long term management.

Appendix 4 – Examples of Good and Poor Installation

Copied directly from Appendix A4 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

GOOD PRACTICE PHOTOGRAPHS



Figure A4.7 Geovent protruding out of the frontage of the unit. Gas membrane along the sides of the slab preventing lateral gas ingress (courtesy Alderburgh Group)



Figure A4.8 Geovent beneath the 2000g taped gas membrane lined up with collector pipes (courtesy Alderburgh Group)



Figure A4.9 On site schematics to aid construction workers build the gas protection system (courtesy Alderburgh Group)

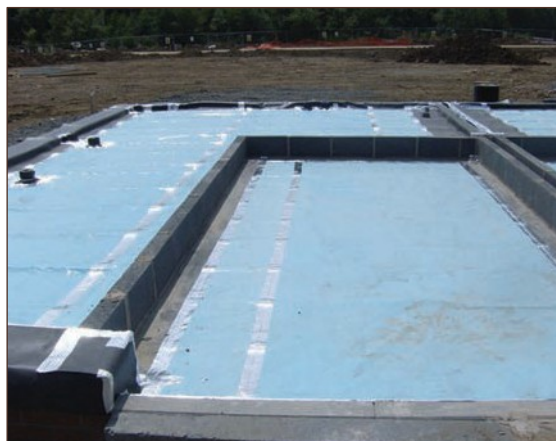


Figure A4.10 Almost complete coverage available for inspection, minimal jointing, service entries suitable distance from walls, light traffic (courtesy Smith Grant)



Figure A4.11 Gas membrane continued through cavity wall and above air bricks (courtesy Hydrock)



Figure A4.12 Good edge detail across cavity (courtesy PAGEotechnical Ltd)



Figure A4.13 Gas proof DPC adhered on top of gas membrane using butyl strips across cavity space (courtesy NHBC)



Figure A4.14 Good perimeter seal (courtesy PAGEotechnical Ltd)



Figure A4.15 LDPE type gas membrane overlap and double sided tape. Sand blinding to protect underside of gas membrane (courtesy A Proctor Group)

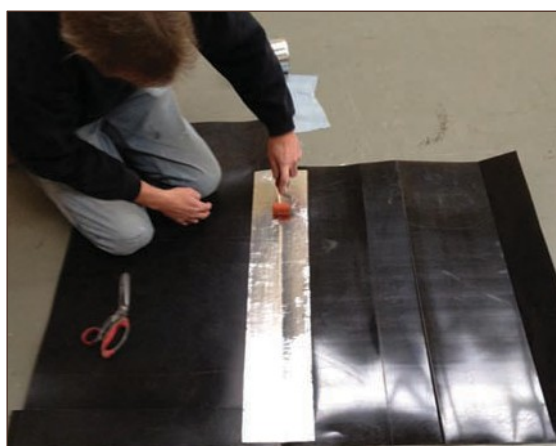


Figure A4.16 Example HDPE type gas membrane and steam roller used to ensure self-adhesive tape is correctly installed (courtesy A Proctor Group)

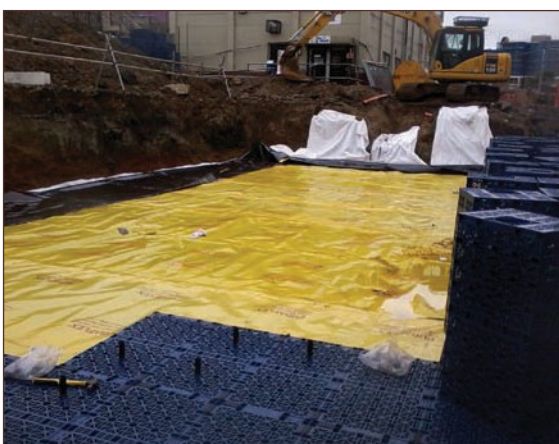


Figure A4.17 Gas membrane installed in attenuation tank (courtesy Industrial Textiles & Plastics Ltd)

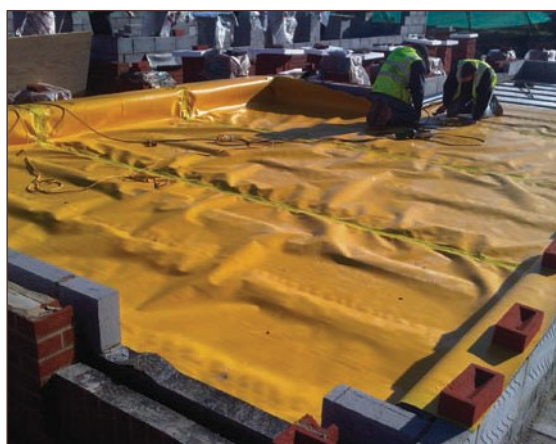


Figure A4.18 Gas membrane installed as part of foundation barrier (courtesy Industrial Textiles & Plastics Ltd)



Figure A4.19 Well-constructed joints with gas resistant DPC, lap and double sided butyl joints visible beneath semi-transparent gas membrane, secondary seal with proprietary single sided tape (courtesy Smith Grant)

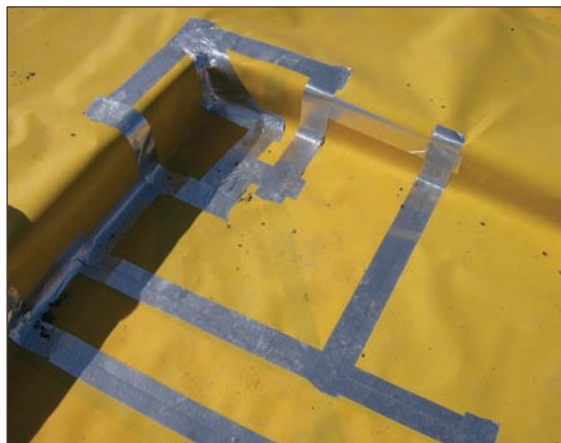


Figure A4.20 A pre-formed corner unit would have been preferable as fewer joints would have been formed, however the installer has achieved a good level of workmanship in this corner detail (courtesy Smith Grant)



Figure A4.21 Good prefabricated corner detail (courtesy MEC Environmental Ltd)

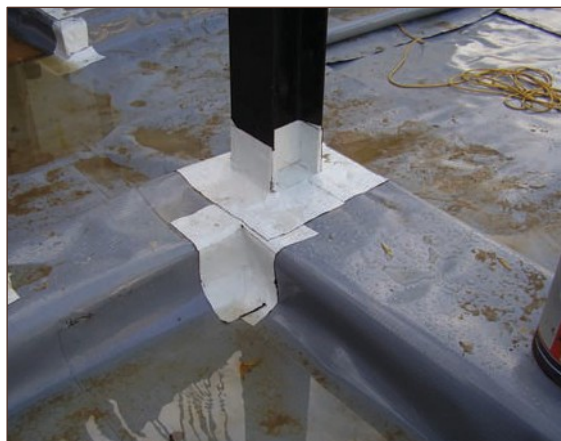


Figure A4.22 Good detail around stanchion and corner (courtesy PAGeotechnical Ltd)



Figure A4.23 Complex column seal (courtesy PAGeotechnical Ltd)

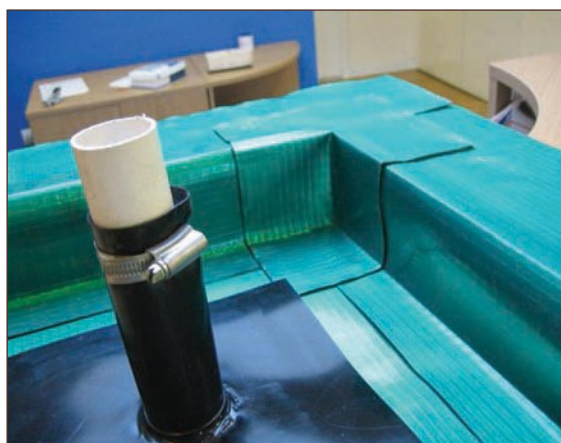


Figure A4.24 Prefabricated corner detail and top hat (courtesy A Proctor Group)

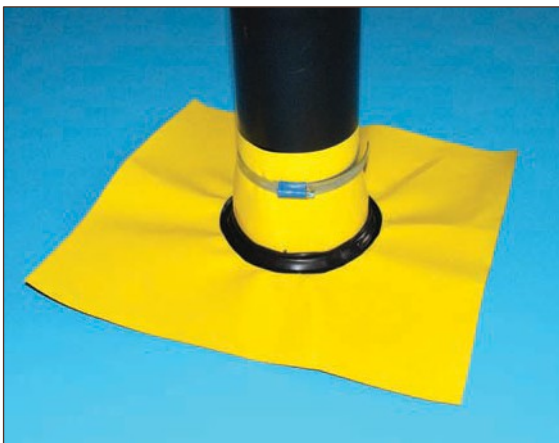


Figure A4.25 Top hat around service entry (courtesy Industrial Textiles & Plastics Ltd)

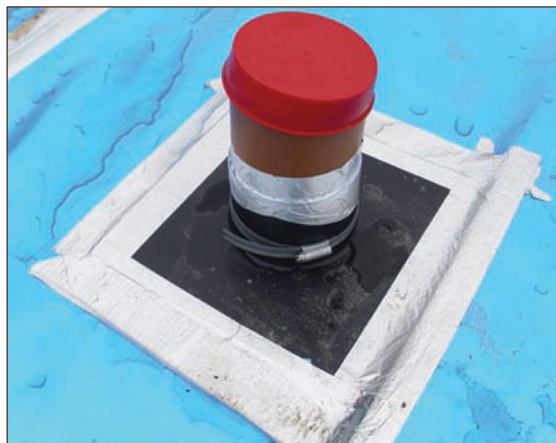


Figure A4.26 Well-constructed service entry: top hat fits well with service pipe and taped down to gas membrane, secondary seal with proprietary single sided tape (courtesy Smith Grant)

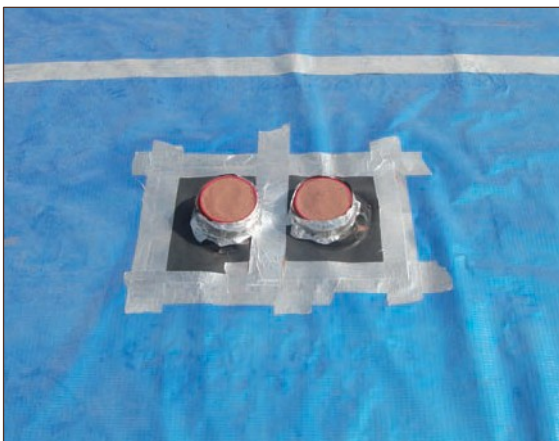


Figure A4.27 Top hats placed around service entries secured with jubilee clip seals. Top hats secured to gas membrane with double sided butyl tape (courtesy Hydrock)



Figure A4.28 Bead of double sided butyl tape provided between interfaces of ID top hat and OD service pipe. When compressed with jubilee clip, forms an effective seal (courtesy Smith Grant)



Figure A4.29 Extrusion welding technique (courtesy Industrial Textiles & Plastics Ltd)



Figure A4.30 Thermal welding technique (courtesy Industrial Textiles & Plastics Ltd)



Figure A4.31 Extrusion welding (courtesy PAGeotechnical Ltd)

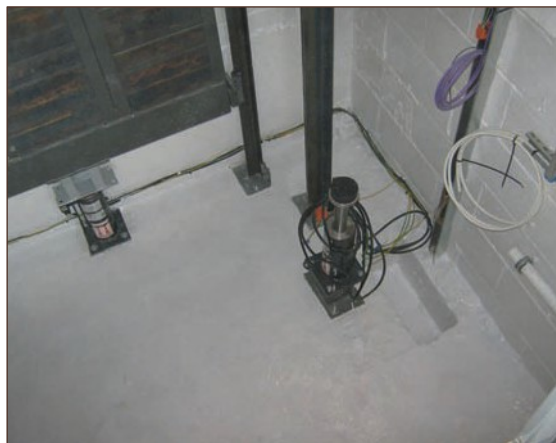


Figure A4.32 High quality installation of liquid gas membrane to lift pits, including resin gas protection on all screw penetrations (courtesy Card Geotechnics Limited)

A4.2.2 Good practice – passive venting systems



Figure A4.33 Good ventilation in internal sleeper walls, cast into prefabricated beams (courtesy Smith Grant)



Figure A4.34 Open void >300mm deep, good ventilation through internal sleeper walls (courtesy Smith Grant)



Figure A4.35 Good installation of passive gas venting trenches and 'egg-crate' (courtesy Card Geotechnics Limited)



Figure A4.36 Raised air bricks are preferable due to the reduced potential for blockade but the vent trench specified is provided with clean single sized stone (courtesy Smith Grant)

A4.2.3 Good practice – integrity testing



Figure A4.37 Tracer gas testing, whereby gas or smoke is applied under pressure beneath the installed gas membrane and detectors are used to screen for leaks above (courtesy NHBC)



Figure A4.38 Tracer gas testing (courtesy PAGEotechnical Ltd)



Figure A4.39 Scanning for leaks (courtesy PAGEotechnical Ltd)



Figure A4.40 CO₂ injection integrity testing (courtesy Landline Ltd)

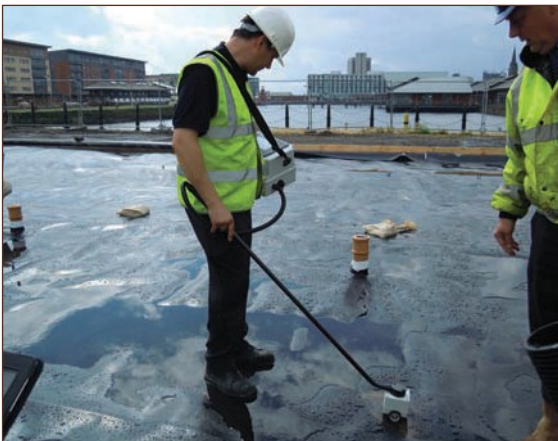


Figure A4.41 Small sand bags are marking holes made in the gas membrane used to check whether injected CO₂ has worked its way beneath whole area (courtesy Landline Ltd)



Figure A4.42 Air pressure testing (courtesy GSE Environmental)



Figure A4.43 Dielectric porosity testing for housing scheme (courtesy NHBC)



Figure A4.44 Air lance test, used to test the quality of welded seams along gas membrane joints (courtesy MEC Environmental Ltd)



Figure A4.45 Spark testing (courtesy GSE Environmental)



Figure A4.46 Testing a weld with 'dog bone' grips (courtesy MEC Environmental Ltd)

BAD PRACTICE PHOTOGRAPHS



Figure A4.47 Follow-on works purposefully penetrating gas membrane (courtesy Card Geotechnics Limited)



Figure A4.48 Loose nails and over construction debris likely to be left in place beneath gas membrane – poor preparation of gas membrane prior to sealing service penetration (courtesy Card Geotechnics Limited)



Figure A4.49 *Lifted gas membrane at corner position. Light penetrating through confirms damage to aluminium internal core layer (courtesy NHBC)*



Figure A4.50 *Large/heavy/sharp objects being moved over unprotected gas membrane (courtesy Card Geotechnics Limited)*



Figure A4.51 *Gas membrane torn by reinforcement (courtesy MEC Environmental Ltd)*



Figure A4.52 *Gas membrane cut by scaffolders and bricklayers after installation (courtesy MEC Environmental Ltd)*



Figure A4.53 *Gas membrane left exposed for long period of time, shows significant fraying at cavity edge (courtesy NHBC)*



Figure A4.54 *Gas membrane damage/tearing at edge of ground floor slab screed layer where it was left exposed to elements for period of time (courtesy NHBC)*



Figure A4.55 Gas membrane at stepped junction of slab to integral garage, appears to be susceptible to tearing when screed is poured. Screed may also weigh down on gas membrane if fitted too tight (courtesy NHBC)



Figure A4.56 Gas membrane at edge of concrete screed. Screed has been grinded to achieve desired levels, gas membrane shows extreme wear and damage as a result (courtesy NHBC)



Figure A4.57 Unprotected gas membrane damaged by heavy traffic (courtesy MEC Environmental Ltd)



Figure A4.58 Damage caused to gas membrane by follow-on trade who cut/shaped the dry lining board directly on the unprotected installed gas membrane (courtesy NHBC)



Figure A4.59 Gas membrane slit at the bottom of a cavity tray to enable water to drain away (courtesy Smith Grant)



Figure A4.60 Some stones could penetrate gas membrane if sufficient force is applied (courtesy Smith Grant)



Figure A4.61 'Stripping' occurs on gas membranes that contain aluminium foil. The foil gets too hot under the outer layer of LDPE or PP and the top layer of the gas membrane sticks to the roller which strips it off, leaving the aluminium completely exposed (courtesy MEC Environmental Ltd)

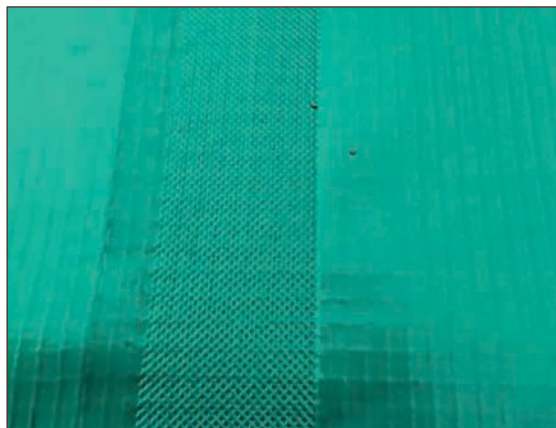


Figure A4.62 Wedge weld on an LDPE aluminium gas membrane, where the installer used metal nip rollers. This destroyed the top layer and probably the bottom layer, leaving aluminium exposed between the weaves. This failed dielectric testing along all joints (courtesy MEC Environmental Ltd)

A4.3.2 Bad practice – gas membranes installed incorrectly



Figure A4.63 Absence of surface preparation prior to laying of gas membrane, debris likely to pierce gas membrane (courtesy Card Geotechnics Limited)

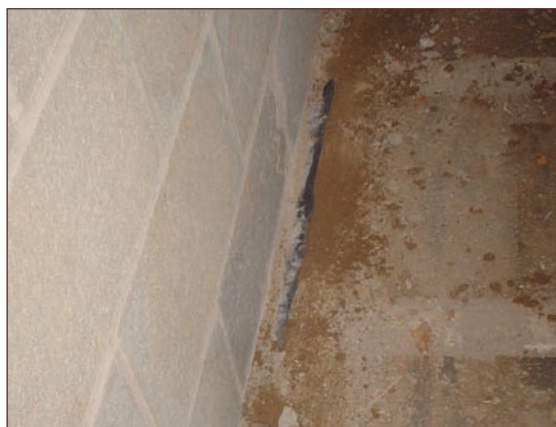


Figure A4.64 Insufficient length of gas membrane protruding through wall to overlap with gas membrane within building (courtesy Card Geotechnics Limited)



Figure A4.65 Wrinkling of gas membrane over joint has resulted in gaps (only visible due to the use of a transparent gas membrane) and the secondary seal uses ordinary gaffer tape rather than a proprietary product (courtesy Smith Grant)



Figure A4.66 Follow-on trades proceeded work before gas membrane joints sealed (courtesy Card Geotechnics Limited)



Figure A4.67 Traffic over mesh resulted in several punctures, in addition most joints were found to be poorly constructed. Taped joints are difficult to construct in adverse weather (courtesy Smith Grant)



Figure A4.68 A pre-formed corner unit would have been preferable. The installer could not produce sufficient quality despite the amount of tape applied (courtesy Smith Grant)



Figure A4.69 Attempt at corner detailing using non-proprietary duct tape (courtesy Smith Grant)



Figure A4.70 Inadequate corner detailing. The use of preformed proprietary products would have avoided such bad practice (courtesy NHBC)



Figure A4.71 No corner detailing leading to stress point on gas membrane (courtesy Smith Grant)



Figure A4.72 Joint between top hat and gas membrane has lifted due to poor fit and attempt to construct in very wet conditions (courtesy Smith Grant)



Figure A4.73 No bead of double sided butyl tape provided between interfaces of ID top hat and OD service pipe: cannot be compressed enough to form seal (courtesy Smith Grant)



Figure A4.74 Gap between OD of service pipe and ID of top hat too large: cannot be compressed enough to form seal, even with the application of additional tape (courtesy Smith Grant)



Figure A4.75 Jubilee clip on service entry insufficiently tightened so joint is uncompressed (courtesy Smith Grant)



Figure A4.76 No double sided tape used in joints (courtesy Smith Grant)



Figure A4.77 Small lap and no single sided tape used to achieve secondary seal (courtesy Smith Grant)



Figure A4.78 Gap in jointing over wall cavity big enough to insert fist (courtesy Smith Grant)



Figure A4.79 Gas membrane not continuous over internal wall. It had been deliberately cut open for unknown purpose (courtesy Smith Grant)



Figure A4.80 Column left unsealed (courtesy PAGEotechnical Ltd)



Figure A4.81 No seal to perimeter pipe (courtesy PAGEotechnical Ltd)



Figure A4.82 Gas membrane used to bridge cavity wall instead of DPC, leaving it exposed to damage by follow-on trades (courtesy Smith Grant)



Figure A4.83 Poor quality installation of liquid gas membrane. Liquid gas membranes come in two colours (black and white) allowing coverage of each coat to be easily assessed. Here the gas membrane has been spread too thinly and inconsistently. In addition, it appears to have been applied to a damp surface, causing blistering (courtesy Card Geotechnics Limited)



Figure A4.84 Taped joints are difficult to construct in adverse weather. Also difficult to inspect if covered with snow (courtesy Smith Grant)

A4.3.3 Bad practice – passive venting systems



Figure A4.85 Clean single sized stones with no fines acting as venting media, however no ventilation gaps in internal sleeper walls (courtesy Smith Grant)



Figure A4.86 Cavity is becoming blocked with detritus. The vent holes in the beam are no longer visible (courtesy Smith Grant)

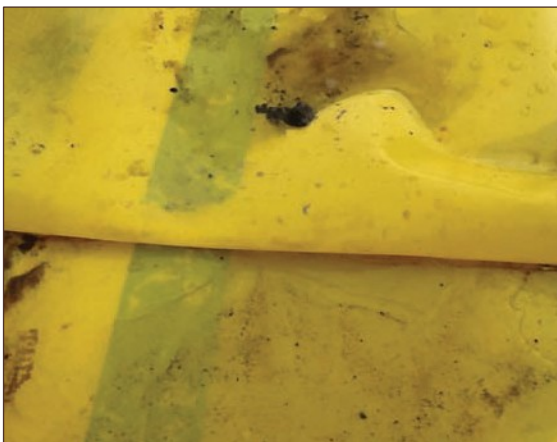


Figure A4.87 Tape joint with crease running through and air bubbles where gas membrane not in complete contact with tape. Rollers should have been used to produce a consistent seal (courtesy MEC Environmental Ltd)



Figure A4.88 Ventilator becoming detached to fit to external block work. This is due to builders requiring increased cavity widths to achieve thermal properties expected by Building Regulations (courtesy NHBC)



Figure A4.89 No ventilation in internal sleeper wall (courtesy Smith Grant)

Appendix 5 –Verification Proforma

Copied Directly From Appendix A5 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

VISUAL INSPECTION OF GAS PROTECTION MEASURES

Site name:	Gas characteristic situation:
Job number:	Type of development and building/block checked: (residential/commercial/other)
Date:	Building description:
Visit by:	Foundation type: (suspended floor/raft/other)
Weather at time of inspection:	Gas protection type: passive/active

No.	Item	Comments (see notes)
1 Gas membrane		
1.1	Condition of sub-grade and underside of gas membrane	
1.2	Gas membrane type	
1.3	Gas membrane condition	
1.4	Joining tape product	
1.5	Lapping design	
1.6	Laps, welds and joints seals	
1.7	Service entries seals	
2 Passive venting		
2.1	Sub-floor void	
2.2	External wall airbricks	
2.3	Internal sleeper walls	
2.4	External vent trenches/ducts	
3 Active venting		
3.1	System details	
Additional notes:		

Notes: inspection checklist

1.1	Underside of gas membrane	Check that the sub grade does not contain rough/uneven surfaces, is appropriately clean and that there are no hard/sharp objects. That protective sand blinding or geotextile (if specified) is present and meets the design criteria.
1.2	Gas membrane type	Manufacturer and product specification, gauge, colour, brand/name, material batch/roll numbers, storage arrangements (protected from dirt/damage?)
1.3	Gas membrane condition	Open punctures, tears, rips, stretching? Excessive footprints/evidence of traffic? Presence of debris? Repairs? Signs of weakness such as raised or sunken indentations? Protection plan in place to restrict access to lain gas membrane?
1.4	Joining tape product	Product type, brand, thickness, material, width, colour? Use of double sided tape?
1.5	Lapping design	Joints lapped and sealed in accordance with manufacturer's requirements/ specification? Minimum overlap insured? Sections taped twice?
1.6	Laps and joints sealed	Welds complete? Appropriate joining/double sided tape used?
1.7	Service entries sealed	Top hats seal arrangements fixed around service entries? Use of Jubilee clips?
2.1	Sub-floor void	Is a check possible? Void former? Gravel (type/specification)? Height of void space? Is it clear?
2.2	External wall airbricks	Numbers, size, positions as design drawing?
2.3	Internal sleeper walls	Ventilation holes (honeycomb brickwork/pipe crossings?) – size, spacing, location in accordance with design?
2.4	External vent trenches/ducts	Located and constructed in accordance with design drawings? If open-topped gravel – gravel type/presence of fines? If pipe or other vent, check position and construction for functionality and absence of blockages. Ability of void former to withstand bearing of the superstructure?
3.1	Active venting	Type of air supply: mechanical, natural, combined? Location/condition/number of fans and vents? Location and size of inlets? Provision of air-cleaning devices and air heaters? Supply and exhaust ductwork? Alarm provision/installation? Gas monitoring system in under-floor void?

Photographs

No.	Description

The gas protection measures inspected:	a Are acceptable and comply with the specification
	b Are acceptable but attention is drawn to issues related to item no. xxx
	c Are not acceptable due to the issues related to item no. xxx

Name:

Signature:

Date: