
**Proposed Residential Development,
Glan Gors, Wrexham.**

Environmental Implementation Plan

Stage 2 – Ground Gas Mitigation

Prepared For:
Pennaf Housing Group and Wrexham County Borough Council

Report Prepared By:
Simon Reynolds
Director of Civil Engineering

April, 2014

Report Number: 6503/SR/Imp2

Document Control

Project Title: Proposed Residential Development – Glan Gors Wrexham

Report Title: Environmental Verification Report - Stage 2 – Ground Gas Mitigation

Project No: 6503

Status: Final

Client Company Name: Keepmoat

Document Approval Record: Approved

Report Prepared By:

Simon Reynolds

Director of Civil Engineering

simonr@bayassociates.co.uk

Document Approval Record

	Name	Signature	Date	Position
Prepared by	Simon Reynolds		17 th April 2014	Director
Checked by	Martin Watkins		17 th April 2014	Director
Approved by	Simon Reynolds		17 th April 2014	Director

Document Revision Record

Issue	Date	Description

COPYRIGHT AND DISCLAIMER

The contents of this document must not be copied or reproduced in whole or in part without the written consent of Bay Associates Consulting Ltd.

CONTENTS	Page No
1.0 Introduction	4
2.0 Report Objectives	5
3.0 Summary of Remediation Strategy	5
3.1 Summary of ground conditions	5
3.2 Summary of groundwater	6
3.3 Summary of ground gas monitoring	6
3.4 Summary of gas mitigation	8
3.5 Gas mitigation design parameters	8
3.6 Selected gas mitigation options	8
3.7 Summary of workmanship testing and independent validation of proprietary gas membrane.	9
3.7.1 Workmanship.	
3.7.2 Independent testing and validation.	
4.0 Implementation	10
4.1 Installation and workmanship	
4.2 Independent testing and verification	
5.0 Ground Gas Monitoring	12
6.0 Health and Safety Procedures	12
7.0 Site Wide Verification Report	12
8.0 Conclusion.	13
Appendices	
Appendix A	Site Location Plan
Appendix B	Drawing 6503-0011/Rev A – Gas Membrane Details
Appendix C	Ground Gas Passive Venting Calculations
	Monarflex Reflex Super Gas Membrane Specification
Appendix D	PAGeotechnical Supporting Documentation
	• Method statements • Risk Assessments • NVQ level 2 gas installation qualification certificates.
Appendix E	Copy of MEC environmental Validation integrity plan
Appendix F	Bore Hole constraints drawing 6503 - 131

1.0 INTRODUCTION

Bay Associates Consulting Ltd (BA) have been instructed by Pennaf Housing Group to develop the Remediation Strategy, Implementation Plan and Verification reports for the proposed redevelopment of land known as Glan Gors, off Anthony Eden drive, Wrexham. The site location is shown in Appendix A.

The development proposal comprises 8No flats and 15No low rise residential units with gardens, adoptable highway and footway access and associated landscaping.

This report is part of a staged assessment of the site, set out below are the preceding investigations and reports/responses which have informed this staged assessment to date

The following studies were undertaken by Wrexham County Borough Council as part of a Stage 2 Contamination Assessment Reports undertaken over land to the north of the study area which was a former landfill know as Bala Road Landfill. These reports included:

- Former Landfill Sites Stage 2 Contamination Assessment – Bala Road – commissioned by Wrexham County Borough Council. Oct 2007. Smith Grant LLP. Report R786-R27(BalaS2)(Final Rev1)
- Former Landfill Sites Stage 2 Contamination Assessment – Bala Road – commissioned by Wrexham County Borough Council. Oct 2007. Smith Grant LLP. Report R786-R54(BalaS2 Add)
- Former Landfill Sites Stage 2 Contamination Assessment – Review and Update of Previous B20(c) Investigation Works Under Part IIA Bala Road – commissioned by Wrexham County Borough Council. Oct 2012. Smith Grant LLP. Report R1661-R10(V2)

The investigations of the Bala Road landfill were undertaken as part of a Part 2A assessment into former landfills but provided useful information on the potential study site characteristics which formed part of the Bala Road Landfill and informed the site specific desk study and intrusive investigation works undertaken by E-geo Solutions Ltd,

- Stage 1 Desk Study and Preliminary Ground Contamination Risk Assessment - Land at Glan Gors, Anthony Eden Drive, Wrexham, LL13 8TH – Commissioned by Bay Associates Nov 2012 E-geo Solutions Ltd Report E0500S1.P1.R1
- Intrusive Geotechnical and Geo Environmental Ground investigation - land at Glan Gors, Anthony Eden Drive. – Commissioned by Bay Associates August 2013 E-geo Solutions Ltd Report E0500.S1.P2.R1.V5

Upon completion of the intrusive and interpretive investigations Bay Associates have developed in consultation with Wrexham's contaminated land team the following document.

- Proposed Residential Development, Glan Gors, Wrexham.
Detailed Remediation Strategy On behalf of Pennaf Housing Group and Wrexham County Borough Council. - Rev / December 2013

This report sets out the detailed Remediation Strategy (in accordance with CLR 11), which justifies the remediation/mitigation options chosen, indicates the scientific and technical bases of the chosen remediation type as well as indication of site management, site phasing and required licenses.

2.0 REPORT OBJECTIVE

In accordance with 'Model Procedures for the Management of land Contamination' - Contaminated Land Report 11 (CLR 11), the objective of the report is to set out the Implementation Plan, which will translate the remediation strategy into a clear set of remediation activities for the site. This plan will indicate all aspects of design, preparation, implementation and verification.

Due to programme requirements it is intended that the implementation plan will be set out and delivered in two stages.

- 1) Stage 1 - Ground contamination
- 2) Stage 2 - Ground Gas Mitigation

This report will set out **stage 2 - Ground gas mitigation** and translate the ground gas section of the detailed enabling works strategy to include the design, preparation, implementation and verification.

3.0 SUMMARY OF REMEDIATION STRATEGY

3.1 Summary of Ground Conditions

The general stratigraphic sequence at the site is:

- Black topsoil.
- Made Ground – dark brown very silty fine to coarse sand and gravel with some to much plastic sheet, bags, glass bottles and gravel, cloth, metal wire, ash gravel, and cobbles of sandstone.
- Silt – dark and light grey slightly sandy clayey SILT.
- Peat – dark brown to black silty slightly clayey PEAT (in parts).
- Alluvium – brown slightly sandy clayey SILT and medium brown very silty fine SAND.
- Glacial Till – dark brown sandy silty CLAY with much fine to coarse gravel and some cobbles

The strata and depths encountered during the investigation were:

Stratum	Description	Depth to base m range (average)
Topsoil	Dark brown silty sandy topsoil	0.10
Made Ground	Loose dark brown very silty fine to coarse sand and gravel with some to much plastic sheet, bags, glass bottles and gravel, cloth, metal wire, ash gravel, and cobbles of sandstone	1.10 – 1.70 (1.50) (2.70m at BD3)
Silt	Very soft to soft dark and light grey slightly sandy clayey SILT	1.90 -2.10 (2.00)
Peat	Very soft dark brown to black silty slightly clayey PEAT (in parts)	1.70 – 3.00 (2.50) (BD1S, BS2, BH 1only)
Alluvium	Soft brown slightly sandy clayey SILT and loose to medium dense medium brown very silty fine SAND with silt partings	8.90 – 10.2 (9.40)
Glacial Till	Stiff dark brown sandy silty CLAY with some to much fine to coarse gravel and some cobbles	17m +

3.2 Summary of Groundwater

Groundwater was encountered in the trial pits and boreholes at the depths shown on the table below:

TP/BH No.	Water encountered	Comment	TP/BH No.	Water encountered	Comment
TP1	0.80	Rapid inflow	BD3S	1.70	Damp
TP2	1.00	Rapid inflow	BH 1	3.00	Medium inflow rising to 1.60 (20 min)
TP3	1.10	Rapid inflow	BH 2	5.50	Slow inflow rising to 3.60 (20 min)
TP4	0.90	Moderate inflow	BH 3	4.00	Slow inflow rising to 3.80 (20 min)
BD1S	1.20	Slight seepage			
BD2S	1.90	Slight seepage			
BS2	2.00	Damp			

Perched groundwater was encountered in the made ground in trial pits at depths of 0.80m to 1.10m, and in the shallow boreholes at depths of 1.20m to 1.90m. Subsequent monitoring in the shallow boreholes indicated the perched water standing at depths of 0.98m to 1.36m.

Shallow groundwater in the alluvial deposits was encountered at depths of 3.00m in BH 1 (rising to 1.60m in 20 minutes), 5.50m in BH 2 (rising to 3.60m in 20 minutes) and 4.00m in BH 3 (rising to 3.80m in 20 minutes)

Monitoring of the installations was undertaken during gas monitoring and water sampling with water levels shown in table below:

TP/BH No.	Water encountered	Comment	TP/BH No.	Water encountered	Comment
TP1	0.80	Rapid inflow	BD3S	1.70	Damp
TP2	1.00	Rapid inflow	BH 1	3.00	Medium inflow rising to 1.60 (20 min)
TP3	1.10	Rapid inflow	BH 2	5.50	Slow inflow rising to 3.60 (20 min)
TP4	0.90	Moderate inflow	BH 3	4.00	Slow inflow rising to 3.80 (20 min)
BD1S	1.20	Slight seepage			
BD2S	1.90	Slight seepage			
BS2	2.00	Damp			

3.3 Summary of Ground Gas Monitoring

Gas monitoring standpipes were installed in all the shallow boreholes with the response zones within the depth of made ground where exchange of atmospheric and soil gasses occur.

Monitoring of the standpipes for methane (% volume), carbon dioxide (% volume), oxygen (% volume), and flow was undertaken with a GA2000 Serial number GA12439.

Initial gas monitoring was undertaken on six occasions over an 8 week period on 15/02/13, 27/02/13, 12/03/13, 20/03/13, 03/04/13, and 11/04/13. Additional monitoring was undertaken on a further six occasions between 01/05/13 and 31/07/13. This extended period of monitoring together with monitoring results from previous gas monitoring over a period which extended from 2007 to 2011 is considered an acceptable period of monitoring to characterize the site particularly with the consistency of the results obtained

Borehole Number	Installation (From ground level down)	Borehole Number	Installation (From ground level down)
BD1S	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround	BD3S	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround
BS1	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround	BS3	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround
BD2S	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround		
BS2	0.00-1.00m(bgl) plain with bentonite surround, 1.00-3.00m(bgl) slotted with 10mm gravel surround		

Table 3 - Gas Monitoring

Previous gas monitoring of installations at the site and adjacent Bala Road Landfill over a period from 2007 to 2011 had indicated consistent methane concentrations less than 1% but with carbon dioxide concentrations greater than 5% but with negligible flow. Based on the previous (by others) and current assessment of risk, the historic low gas concentrations recorded and the low gas generation potential of the materials placed within the site, guidance suggests that a minimum of six gas monitoring visits should be undertaken. This is the minimum normally acceptable to regulators however if site conditions or monitoring results differ from previous findings an extended period of monitoring will be considered.

Groundwater was encountered at shallow depth within the boreholes with. The water inflows were generally at the base of the made ground or interface of made ground and underlying alluvial deposits allowing monitoring of gasses within the unsaturated zone of the made ground.

During the construction of the boreholes water inflow was either not noted or recorded as being very slow with the ground strata becoming damp or only seepages noted at depths of 1.20m to 1.90m (bgl). The absence of moderate or rapid inflows suggests that the strata are of relatively low permeability. However following completion of the monitoring installations standing water levels of 0.98m to 1.36m below ground level were recorded causing the lower portions of the response zones to be flooded.

The water inflows were generally at the base of the made ground or interface of made ground and underlying alluvial deposits which allowed monitoring of gasses within the unsaturated zone of the made ground, however with higher standing water levels the thickness of the unsaturated zone decreased. Although the thickness of the unsaturated zone in some of the boreholes was relatively small it is considered that with the number of boreholes across that site, the type of made ground and the presence of more silty made ground at depth that the gas monitoring results provide a representative indication of the gas regime.

Additional monitoring was undertaken on a further six occasions between 01/05/13 and 31/07/13 when the standing water level reduced which increased the thickness of the unsaturated zone. BH and Trial Pit locations can be seen in Appendix B

3.4 Summary of Gas Mitigation

The investigation findings and the evaluation of risk for the site and its proposed redevelopment with residential properties has identified sources of contamination which present some degree of risk. The risks are primarily associated with the presence of elevated concentrations of chemical parameters and the presence of hazardous ground gasses.

Due to the elevated concentrations of methane and carbon dioxide the site has been classed as 'amber 2 in accordance with NHBC Guidance on Methane and Carbon Dioxide Report Edition No.04 (March 2007) and CIRIA Publication C659 Assessing Risks Posed by Hazardous Ground Gases to Buildings. All structures and buildings will have to incorporate gas control and protection measures appropriate for the site characterisation category which requires high level gas protection measures, comprising a membrane and ventilated sub-floor void with a minimum of one complete volume change per 24 hours. Provision of venting should be in accordance with current accepted guidance and standards.

All risk control and mitigation measures undertaken at the site should be carefully controlled and checked in accordance with best quality control procedures. Gas protection and control measures in particular should be checked at each stage of installation in accordance with current guidance. The method and frequency of validation and certification should be detailed in the Remediation Strategy and implementation plan

3.5 Gas Design Parameters

The maximum results obtained from the monitoring regime classify the site as Amber 2 in accordance with NHBC guidelines or gas characteristic 3 in accordance with CIRIA C665 These guidelines can be used to inform the design strategy for the form and occupancy type of building.

3.6 Selected Gas Mitigation Options

In determining the gas mitigation methods based on the guidelines provided by NHBC and CIRIA C665 reference is made to the following British standard

BS 8485:2007 'code of practice for the characterization and remediation from ground gas in affected developments.'

Following determination of the site specific gas situation Section 7 of BS8485:2007 sets out the recommended gas protection appropriate for the buildings. As there are a number of existing designs and component elements available in the market this provides a guide as to the relative performance of types of designs and systems available.

The proposed development at this site is one of managed housing however it is recognised that there may be fluidity in ownership during the development lifetime and for that reason the mitigation requirement will be based on that of non-managed private housing.

BS8485:2007 Table 2 advises that the required gas protection will need to achieve a score of 4.

From BS8485:2007 Table 3 sets the levels of protection required to achieve that score and based on the development foundation solution these comprise

- Passive subfloor venting to achieve very good performance
- Proprietary gas resistant membrane installed to reasonable levels of workmanship/inline with current good practice under CQA with integrity testing and independent validation

Construction make up for ALL plots will comprise the following (Selected Gas Protection measures to achieve a score of 4.5)

- Beam and Block flooring comprising
- 65mmscreed on
Isolation layer on
125mm kingspan TF70 Urethane insulation on
PAGeotechnical Monarflex Reflex Super Proprietary gas protection system (All joints and penetrations lapped taped and sealed in accordance with manufacturers recommendations (refer drawing 6503-0011 – Gas membrane details - Appendix B)
Cavity wall tray lapped taped and sealed to gas membrane
- 200mm clear void from underside of beam to ground.
- 225x75mm grilled airbricks and proprietary Periscope vents around perimeter at 2m centres, cross vents to internal load bearing walls to be set at 2m centres. Note Minimum cross sectional area to be 3000mm² per opening in accordance with building regulations Part C 2004 edition (incorporating 2010 amendments) Section 4: walls cl 4.19.

Supporting calculations for passive venting requirements are included within Appendix C

These calculations confirm that using the worst case emission and flow rates and setting design concentration as 1% v/v Co₂ in the voids and vents and utilising a 0.3m/s wind speed, the venting requirements are significantly below that required as a minimum for building regulations and the passive venting provides very good performance.

3.7 Summary of Workmanship testing and independent validation of proprietary gas membrane.

The strategy set out the minimum requirements regarding workmanship, testing and validation. The successful contractor is to ensure and allow for the following workmanship testing and independent validation.

Workmanship.

Contractor is to ensure that the installer of the gas proprietary system is suitable qualified and experienced, installation technicians to be trained to and hold appropriate certification to NVQ level 2 qualification in gas protection installation. Prior to commencing work on site appropriate qualification certification is to be provided to the client team.

Independent Testing and Validation.

The contractor is to employ an independent environmental consultant to carry out integrity testing and certification. Consultant to carry out thorough visual inspection of the first 5 plots including vented void and sub grade and membrane before placement of insulation and screeds. All joints and penetrations corners etc to be air lanced to ASTM D 4437. On successful completion of the first 5 plots independent verification inspections should be

carried out at a rate of 1 in 5. Resulting in testing and verification of 35% of the total of 23 plots.

Note the above statement taken from the remediation strategy has subsequently been superseded to meet Wrexham's specific requirements that ALL plots are tested and validated see 4.2 below

The contractor is to supply plot sign off sheets (verification evidence) including photographs to independent consultant for all other plots.

The contractor is to provide a detailed installation plan, method statements and QA procedures for inclusion within the implementation and subsequent verification plan.

Upon completion of all gas protection works the contractor is to provide all verification and testing reports completed by the independent consultant to the client team for inclusion within the final site wide verification plan.

4.0 Implementation

Following appointment of Keepmoat as the contractor an initial design team meeting with Keepmoat and Bay Associates and was held on the 24th March 2014 to discuss the scheme and set out gas mitigation requirements in line with remediation strategy including procurement of appropriate materials, installation contractor and independent testing and verification as well as programme implications.

Further consultation was held with PAGEotechnical/contracting the specialist suppliers and installers of the chosen gas membrane and the implementation and verification measure are set out below.

4.1 Installation and Workmanship

PAGEo-Contracting are to be appointed to install the gas protection measures set out above, PAGEo-Contracting Ltd is the Contracting arm of PAGEotechnical and are a specialist contractor in all aspects of membrane installation, working alongside Keepmoat, PAG will provide and install to manufactures recommendations the gas protection system set out in the floor make up detailed below

- Beam and Block flooring comprising
- 65mmscreed on
Isolation layer on
125mm kingspan TF70 Urethane insulation on

PAGEotechnical Monarflex Reflex Super Proprietary gas protection system (All joints and penetrations lapped, taped and sealed in accordance with manufacturers

recommendations (refer drawing 6503-0011 Appendix B) Cavity wall tray lapped taped and sealed to gas membrane (refer to architects details)

- 200mm clear void from underside of beam to ground.
- 225x75mm grilled airbricks and proprietary Periscope vents around perimeter at 2m centres, cross vents to internal load bearing walls to be set at 2m centers. Note Minimum cross sectional area to be 3000mm² per opening in accordance with building regulations Part C 2004 edition (incorporating 2010 amendments) Section 4: walls cl 4.19.

A specification of the Monarflex Reflex Super Proprietary gas protection system is provided in Appendix C

As advised by the manufacturer the Monarflex reflex super membrane will be installed with taped joints utilising PAG butyl tape. Corners, cavity closers and pipe penetrations are to be sealed with PAG Self Adhesive Gas Barrier.

PAGeo-Contracting installation operatives are trained and hold appropriate certification to NVQ level 2 qualification in gas protection installation. These qualifications are included in Appendix D

Method statements and installation procedures are provided in Appendix D.

Upon completion of installation a programmed testing regime will be undertaken as noted below. Immediately following testing and signed off verification the main contractor will install the screed on the same day if appropriate or at the commencement of the next working day.

4.2 Independent testing and Verification

Keepmoat have commissioned MEC environmental as an independent testing consultant to validate the integrity of the installed gas membrane MEC environmental will undertake the following

NOTE: In accordance with Wrexham's specific requirements, testing and verification is to be carried out to **ALL** plots.

Carry out a full visual inspection of all plots to include vented void and sub grade and membrane before placement of insulation and screeds. All joints and penetrations corners etc to be air lanced to ASTM D 4437.

MEC environmental will provide plot specific sign off sheets (verification evidence) including photographs.

A sample copy of MEC validation/Integrity plan to be utilised is included within Appendix E

Installation of gas protection measures and associated testing and verification will be identified on the detailed construction programme. Wrexham Council will be advised of construction programme and will be notified 1 week in advance of plot installation to ensure that an officer can attend gas installation and testing if required. It is likely that gas measures will be installed under a rolling programme.

Upon completion of all gas protection works the contractor will provide all verification and testing reports completed by the independent consultant Bay Associates for inclusion within the final site wide verification plan.

5.0 Ground Gas Monitoring

Ground gas monitoring will be undertaken during the construction phase and continued for 6 months following completion of the works, by definition a number of the BH's will need to be removed to facilitate construction, however 1 No shallow and 1 No deep BH will be maintained. It is currently proposed to maintain the BH's displaying the highest readings however exact locations and adjacency to foundations will need to be confirmed by the contractor at the commencement of the works to ensure that the BH's can be maintained.

A BH Constraints Drawing No 6503-131 can be seen in Appendix F

The following BH's will be maintained

- Shallow BH BS 1 which displayed elevated methane and Carbon Dioxide
- Deep BH BD2S which displayed elevated methane

Sampling regime

- Every 2 months during construction phase of 12 months = 6 Visits
- Every 2 months post construction for 6 Months = 3 visits

E-geo Environmental who undertook the gas monitoring for the Geo-environmental Investigation have been commissioned by Keepmoat to carry out the ongoing monitoring/sampling visits.

BH's to be maintained can be seen in Appendix F

6.0 Health and Safety Procedures

Gas Barrier installation risk assessments have been provided by PAGEDO-contracting as follows

- Environmental
- General workplace
- Manual Handling
- Operational Tasks

These documents can be seen in Appendix D. These documents form part of the contractual and CDM obligations with keepmoat.

7.0 Site Wide Verification Report

The verification reports provided by the independent consultant MEC environmental will provide verification of the Stage 2 – implementation works associated with ground gas mitigation. This verification plan along with the Stage 1 – implementation/Verification plan associated with ground contamination will form the nucleus of the overall site wide verification that will be submitted to discharge planning condition 12

This **site wide** verification plan will in accordance with CLR 11 and consultation with the local authority the verification plan and report, set out the data gathering requirements necessary to demonstrate that the remediation/mitigation undertaken meets the site remediation criteria.

The verification plan will be completed upon completion of all works that impact on the ground and will collate the evidence to demonstrate that all works have been carried out in accordance with the remediation strategy and implementation plan. This will include:

- Summary of desk study, site investigation report and remediation strategy.
- Details of who carried out the work.
- Details and justification of any changes from original remediation strategy.
- Substantiating validation data that will include where appropriate:
 - Laboratory and *in-situ* test results.
 - Monitoring results for groundwater and gases.
 - Summary data plots and tables relating to clean-up criteria.
 - Plans showing treatment areas and details of any differences from the original remediation strategy.
 - Photographic and other media records.
 - Waste management details and records.
 - Validation of clean capping depths to gardens
 - Third party validation regarding gas protection installation.
 - Contractors individual plot records and photo's
 - WAC test certificates for waste off site
 - Waste disposal Tickets confirming waste disposal to authorised Facility
 - Plans, drawings and photo's as necessary
- • Confirmation that remediation objectives have been met.

8.0 Conclusion.

In accordance with the Environment Agency Contaminated Land Report 11 (CLR 11) this staged report has been compiled to set out the implementation process which translates the remediation strategy into a clear set of activities to deliver the necessary gas mitigation measures along with the necessary verification requirements to allow production of a site wide verification plan.

Appendix A

Site Location Plan

Site Location Plans

The site is located approximately 1.5km east of the centre of Wrexham, North Wales. The site location is shown on Figure 1 and is centred at Grid Reference 335197,349858. The site which covers an area of approximately 0.6ha (Figure 2) is located off Anthony Eden Drive. Situated between an area known as The Dunks and Cefn Park the site is surrounded by residential properties.

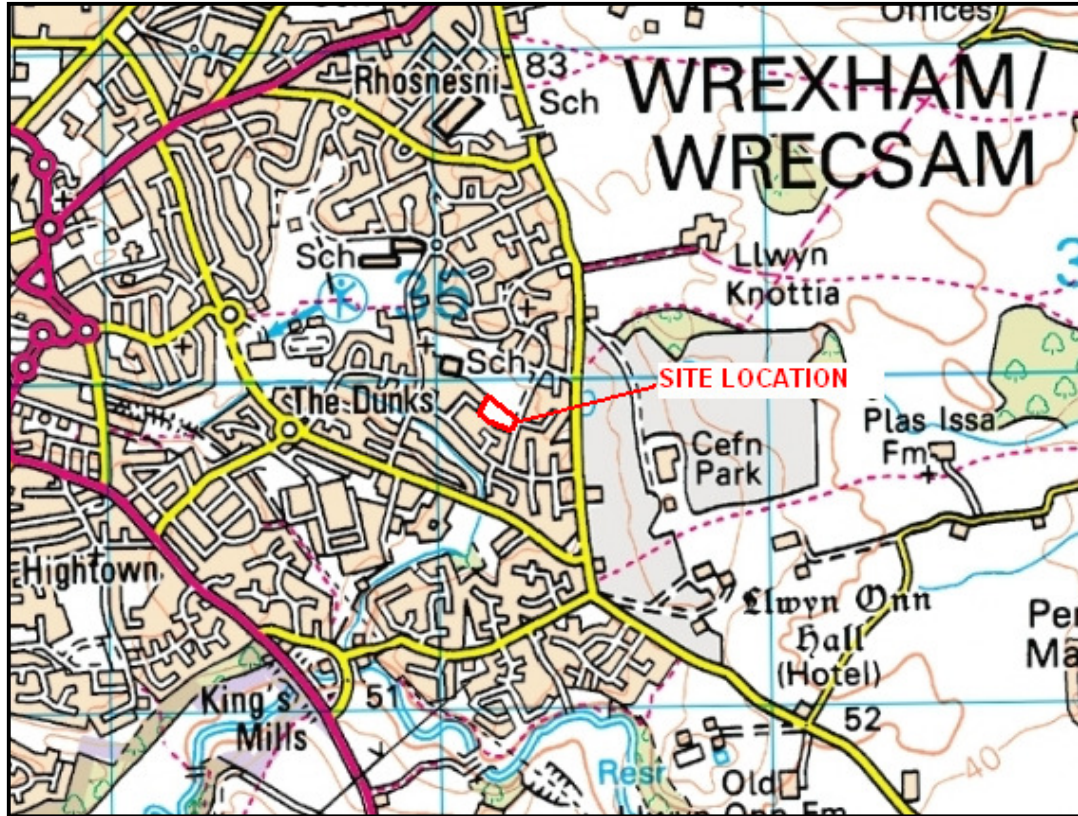


Fig 1

The extent of the site is shown on Figure 2. Access to the site is directly off Anthony Eden Drive to the east. The boundaries of the site are marked by a pathway to the north-west, south-west and south, Anthony Eden Drive to the east, and there is no boundary demarking the north-east boundary.

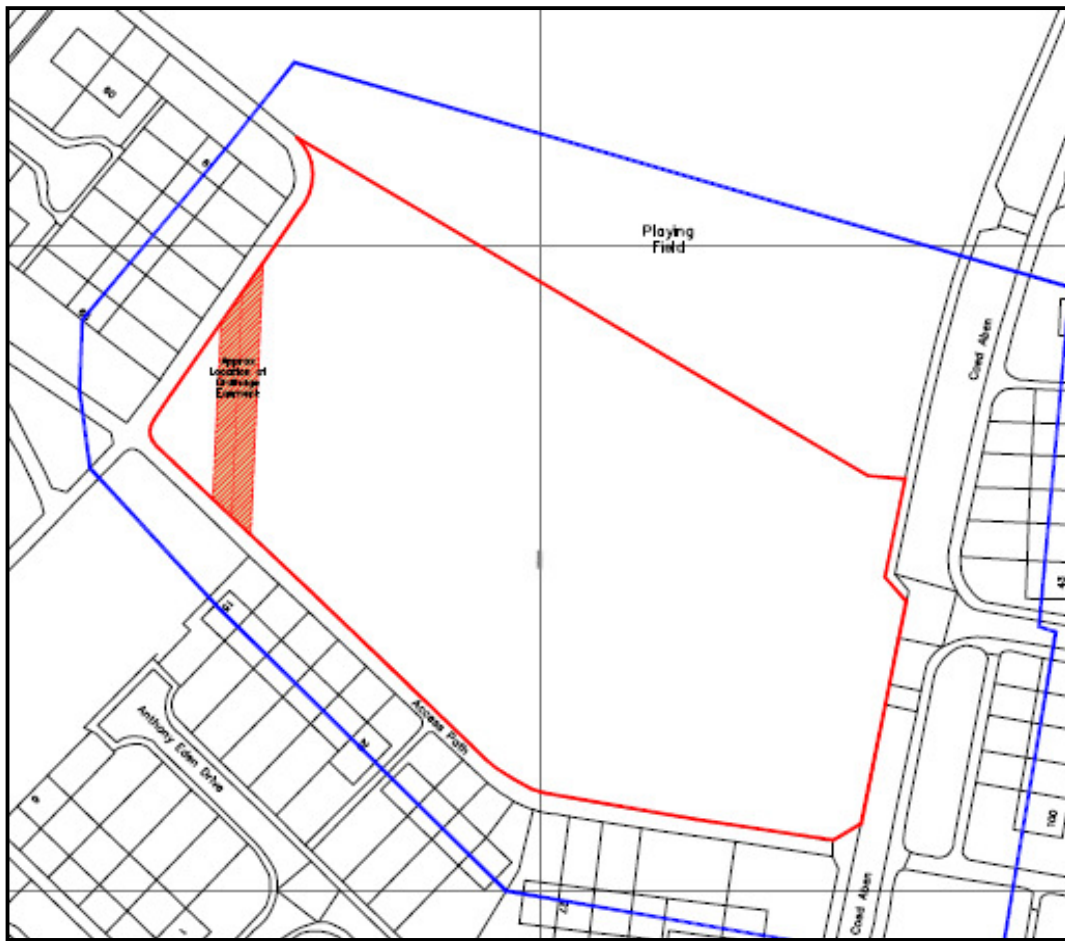


Figure 2 – Site Boundary (red)

Site Description and Topography

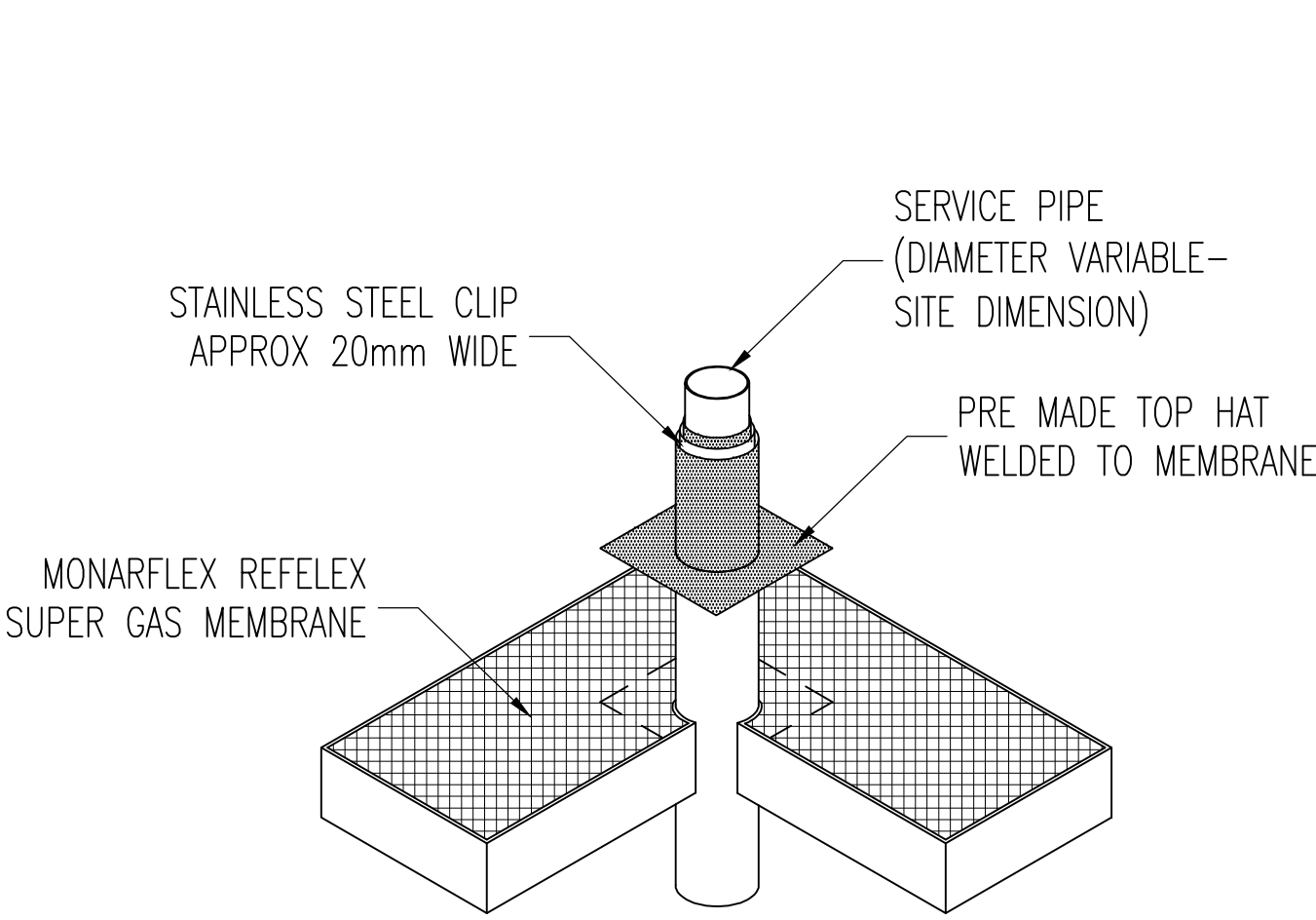
The site is an area of maintained green open space within a residential estate. It is used for recreational use and comprises a grassed relatively flat area of ground. An aerial photograph is shown as Figure 3. The ground surface within the site is generally level and slopes very gently from north-east to south-west from 58.90m aOD to 57.60m aOD. There are residential properties to the east, south and west to north-west. To the north-east is a further area of grassed open space used for informal recreational use.



Figure 3 – Aerial Photograph

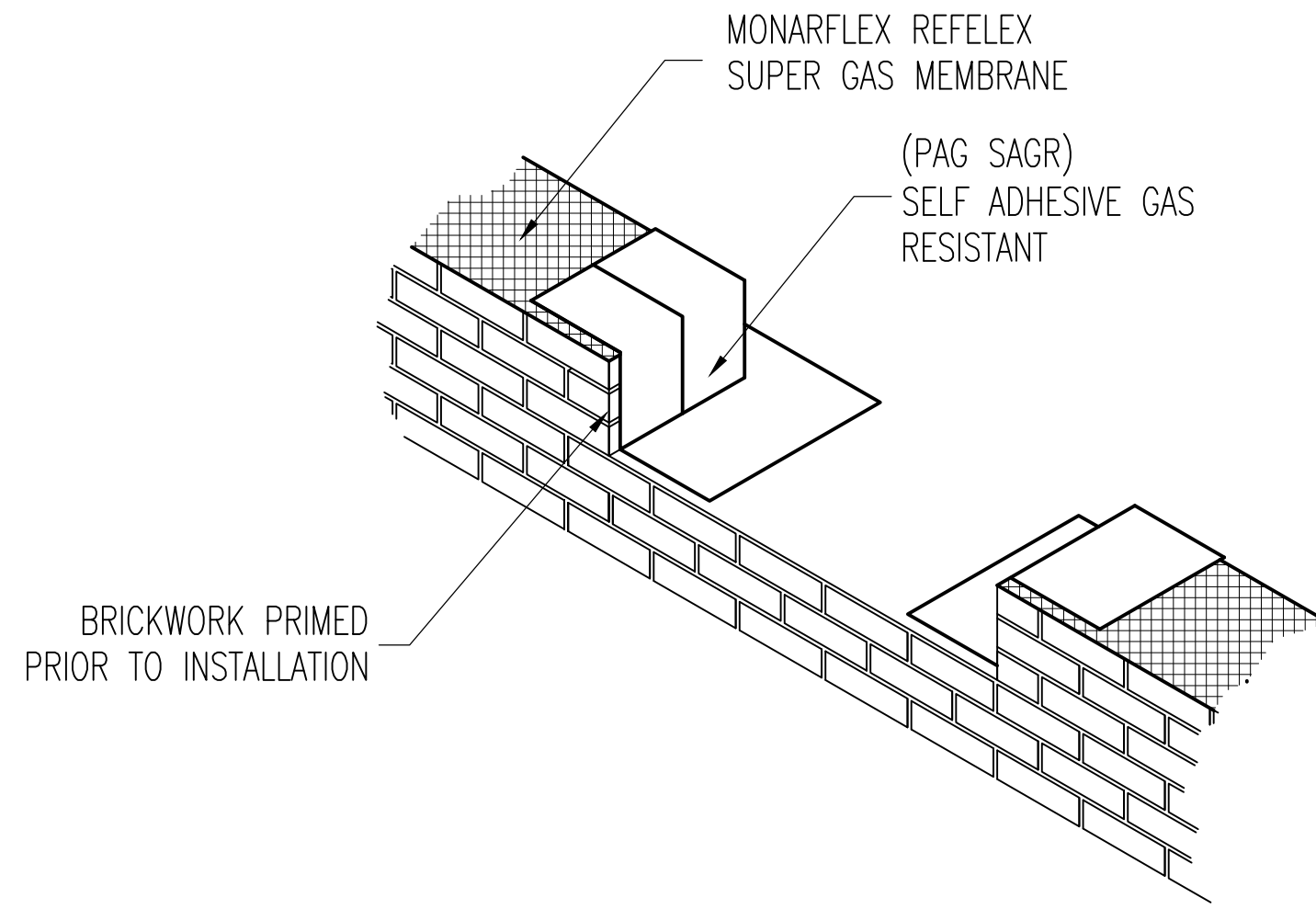
Appendix B

Drawing 6503-0011/rev A – Gas membrane details



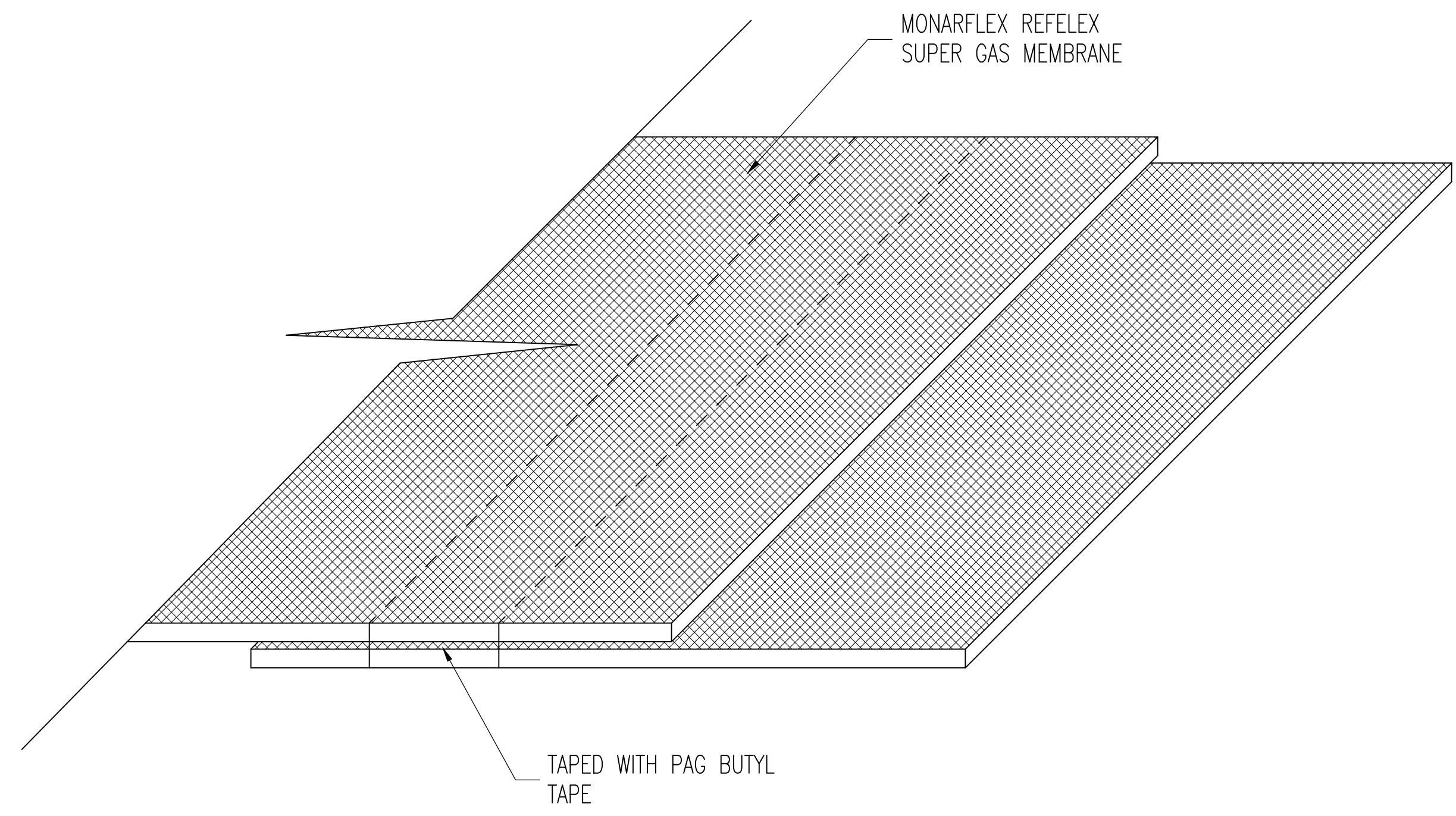
STANDARD TOP HAT TO SERVICE PIPE DETAIL

(N.T.S)



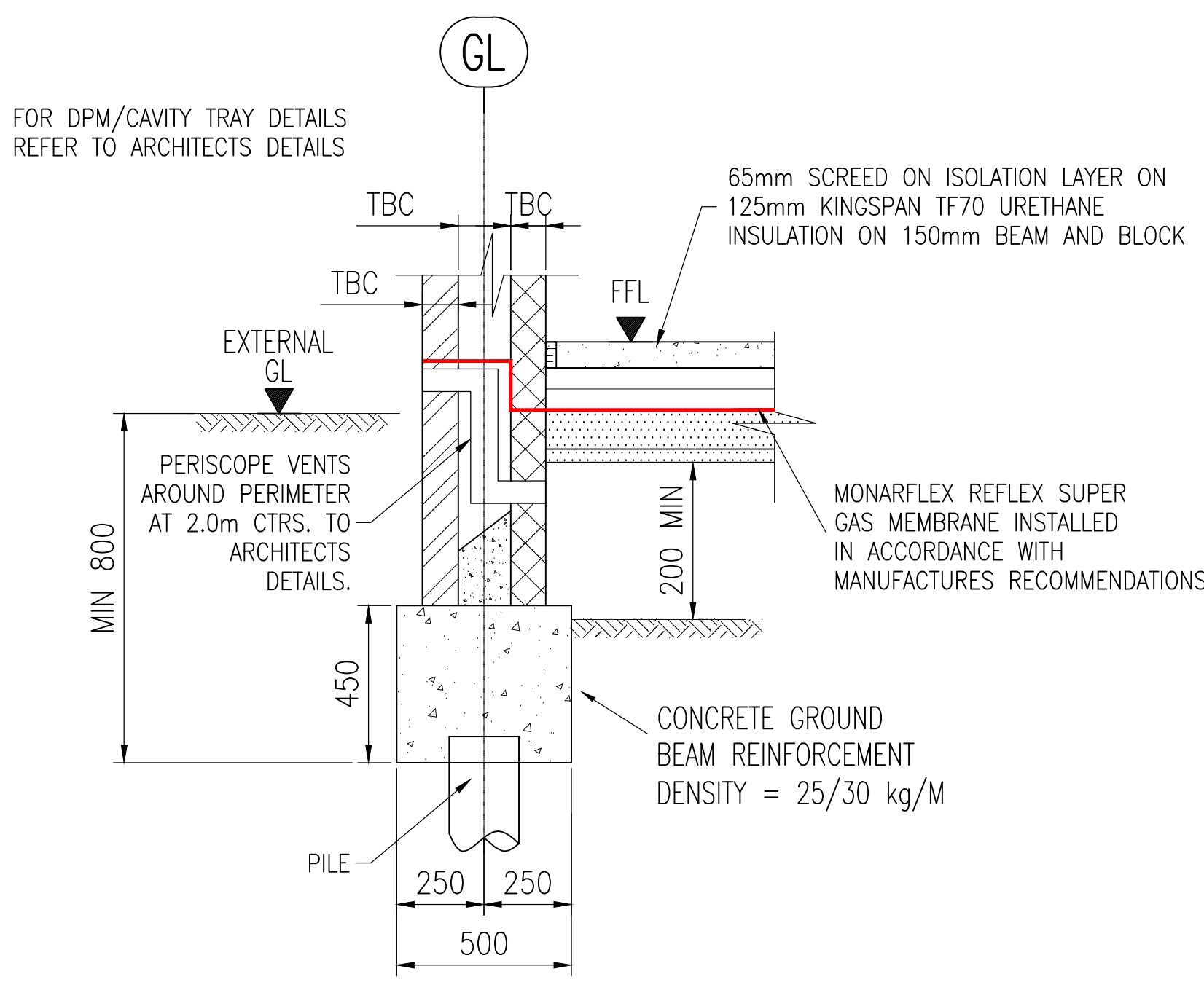
MEMBRANE DETAIL AT DOORWAY

(N.T.S)



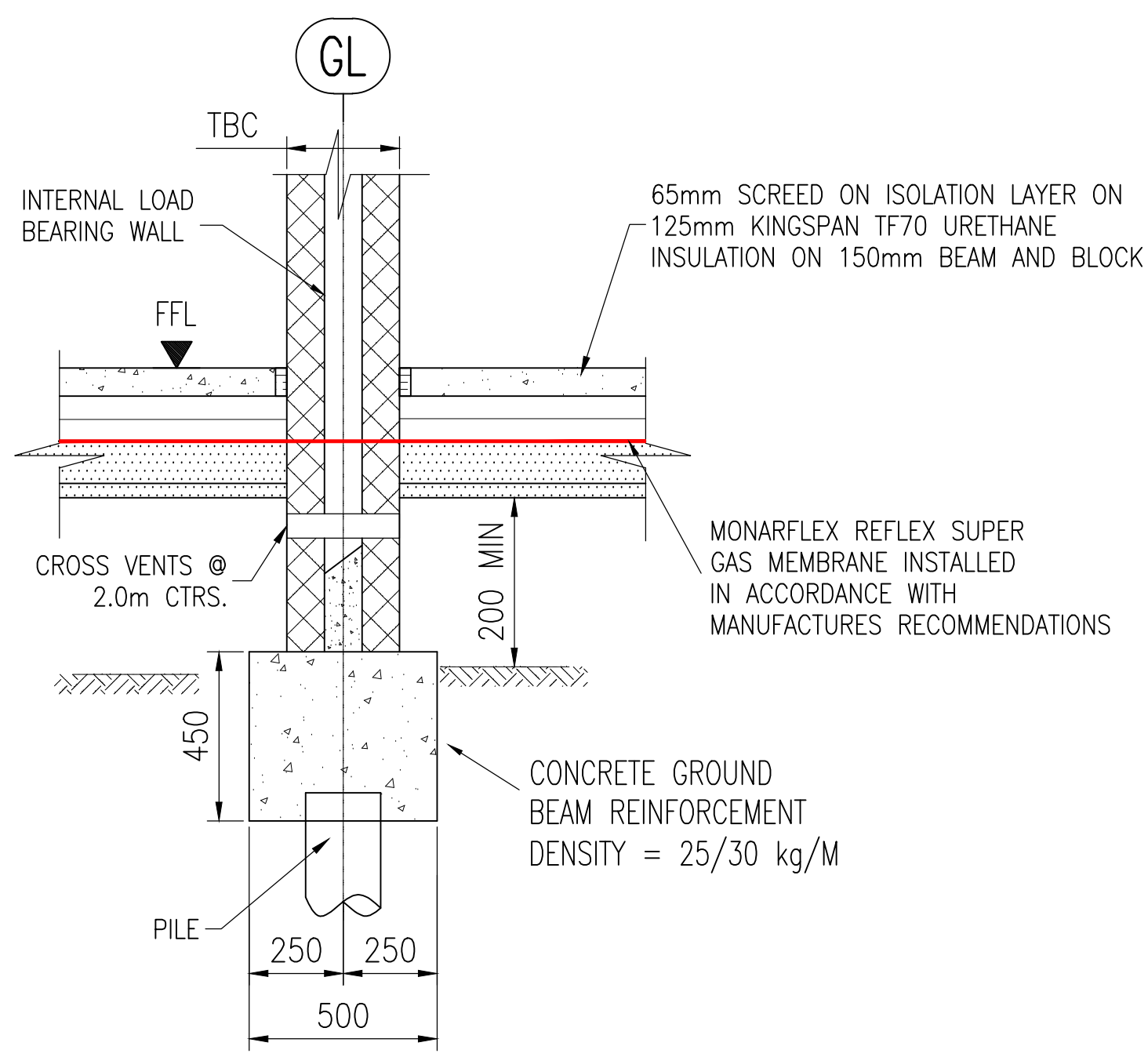
OVERLAP DETAIL

(N.T.S)



TYPICAL EDGE DETAIL

(N.T.S)



TYPICAL PARTY WALL DETAIL

(N.T.C)

WORKMANSHIP TESTING AND INDEPENDENT VALIDATION OF PROPRIETY GAS MEMBRANE

THE STRATEGY BELOW SETS OUT THE MINIMUM REQUIREMENTS REGARDING WORKMANSHIP, TESTING AND VALIDATION AND IS FURTHER COVERED UNDER OUTLINE VALIDATION PLAN

THE SUCCESSFUL CONTRACTOR IS TO ENSURE AND ALLOW FOR THE FOLLOWING WORKMANSHIP TEST AND INDEPENDENT VALIDATION.

WORKMANSHIP

CONTRACTOR IS TO ENSURE THE INSTALLER OF THE GAS PROPRIETARY SYSTEM IS SUITABLE QUALIFIED AND EXPERIENCED INSTALLATION TECHNICIANS TO BE TRAINED TO AND HOLD APPROPRIATE CERTIFICATION TO NVQ LEVEL 2 QUALIFICATION IN GAS PROTECTION INSTALLATION.

PRIOR TO COMMENCING WORK ON SITE APPROPRIATE QUALIFICATION CERTIFICATION IS TO BE PROVIDED TO THE CLIENT TEAM.

INDEPENDENT TESTING AND VALIDATION

THE CONTRACTOR IS TO EMPLOY AN INDEPENDENT ENVIRONMENTAL CONSULTANT TO CARRY OUT INTEGRITY TESTING AND CERTIFICATION. CONSULTANT TO CARRY OUT THOROUGH VISUAL INSPECTION OF ALL PLOTS INCLUDING VENTED VOID AND SUB GRADE MEMBRANE BEFORE PLACEMENT OF INSULATION AND SCREEDS. ALL JOINTS AND PENETRATIONS CORNERS ETC TO BE AIR LANCED TO ASTM D 4437. THE CONTRACTOR IS TO SUPPLY PLOT SIGN OFF SHEETS (VERIFICATION EVIDENCE) INCLUDING PHOTOGRAPHS TO INDEPENDENT CONSULTANT FOR ALL PLOTS

THE CONTRACTOR IS TO PROVIDE A DETAILED INSTALLATION PLAN, METHOD STATEMENTS AND QA PROCEDURES FOR INCLUSION WITHIN THE IMPLEMENTATION AND SUBSEQUENT VERIFICATION PLAN

UPON COMPLETION OF ALL GAS PROTECTION WORKS THE CONTRACTOR IS TO PROVIDE ALL VERIFICATION AND TESTING REPORTS COMPLETED BY THE INDEPENDENT CONSULTANT TO THE CLIENT TEAM FOR INCLUSION WITHIN THE FINAL SITE WIDE VERIFICATION PLAN.

Notes:

0mm 50mm A1 original sheet size

Contact BAY regarding terms & conditions, copyrights, CDM, etc. Check printed scale, responsibility is not accepted for reproduction of digital media or measuring from this document. Only figured dimensions to be used for construction. Report to the Project Engineer any doubts or discrepancies.

- GENERAL NOTES
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
 3. ALL LEVELS RELATE TO ORDONANCE DATUM UNLESS NOTED OTHERWISE.
 4. DO NOT SCALE FROM THIS DRAWING. USE FIGURED DIMENSIONS ONLY.
 5. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
 6. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
 7. THIS DRAWING IS COPYRIGHT© PROPERTY OF BAY ASSOCIATES.
 8. IF IN DOUBT, ASK.

Rv	Date	By	Ch	Revisions	Client	Project	Drawing Title
A	17.04.14	SO	SR	MINOR AMENDMENT TO NOTES	PENNAF HOUSING	RESIDENTIAL DEVELOPMENT GLAN GORS WREXHAM	GAS MEMBRANE DETAILS
Drawing Status TENDER ISSUE					Scale AS SHOWN	Date 26.11.13	Design By NL
Job No. 6503					Drawn By SO	Checked NL	Drawing No. 011
Rev. A					Bay Associates Civil + Structural Engineers 21/22 Neptune Court, Vanguard Way, Cardiff, C F 2 4 5 P J t:029 2045 1011 f:029 2037 4690 e:bay@bayassociates.co.uk w:www.bayassociates.co.uk		
ice					CARDIFF ☒ REDDITCH ☐ LONDON ☐		
BAY					CIVIL + STRUCTURAL ENGINEERING		

Appendix C

Ground Gas Passive Venting Calculations

Monarflex Reflex Super Membrane Specification

Ground Gas Venting Calculations

Calculations below based on worst case scenario i.e.

Largest building footprint.

Worst Case recorded Gas levels recorded over 6 Months in all 6 No Boreholes

Worst case Flow rate recorded over 6 Months in all 6 No Boreholes

Co2 – Gas Calculation

Based on The Chartered Institute of Environmental Health - The local Authority Guide to Ground Gas 2008

Worst case CO₂ - 14.5%

Worst case flow - 1.2 l/hr

Floor area - 59.25m²

Surface Emission rate = $0.145 \times 1.2 \text{ l/h} / 10 = 0.0174 \text{ l/hr/m}^2$ or **$1.74 \times 10^{-5} \text{ m}^3/\text{hr}$**

Total Building area = 59.25m²

So total surface emission rate of gas into void $q = 1.74 \times 10^{-5} \times 59.25 = \mathbf{0.001031 \text{ m}^3/\text{hr}}$

Set design concentration as 1% v/v CO₂ in the void and vents. (Conservative)

Q = Design fresh air required - $0.00103 \text{ m}^3/\text{hr} \times 99 = \mathbf{0.1021 \text{ m}^3/\text{hr}}$

The ventilation system must provide this volume of air flow to provide sufficient dilution of the gas emissions.

Vent sizing

Assume a wind speed of 0.3m/s. (Conservative)

Now calculate the required vent A_w area to give the fresh air - Q.

Assume discharge coefficient for a narrow opening - $C_d = 0.61$

Building orientation unknown - $C_p = 0.4$ (Conservative)

Area of ventilation for the whole building A_w is calculated using BS 5925:1991

$Q = 0.1021 \text{ m}^3/\text{h}$ and needs to be converted to $\text{m}^3/\text{s} = 0.1021/3600 = 2.8 \times 10^{-5} \text{ m}^3/\text{s}$

$$Q = \frac{2.8 \times 10^{-5} \times 10^6}{0.3 \times 0.61 \times 0.63}$$

$$A_w = \mathbf{245 \text{ mm}^2}$$

This equals to $245 \text{ mm}^2 / 15 \text{ m}$ (Max longest wall length) = 16.33 mm^2 per m/run

This is less than the minimum venting area required in the Building Regulations of $1500 \text{ mm}^2/\text{m}$ so therefore the minimum vent area should be provided. This is set out in the detailed remediation strategy at 225×75 grilled airbricks at 2m centres with minimum cross sectional area of 3000 mm^2 to be provided at each opening. Cross vents through internal ground beams to be set at 2.0m centres also.

Reference Documents:

The Chartered Institute of Environmental Health - The local Authority Guide to Ground Gas
2008

BS 5925:1991 – Ventilation Principles and designing for Natural Ventilation.

BS 8485:2007 – Code of Practice for the Characterization and remediation from ground gas
in affected Developments.

CIRIA Report 149 -Protecting Development from Methane

Properties:

The MONARFLEX® Reflex Sand/Black membrane is a six layer gas and moisture barrier. Top layer is sand coloured and bottom layer is black.

Product data	Monarflex® Reflex Sand/Black			
Composition:				
Top layer	LDPE with stabilizers, Sand (brown)			
Coater layer	LDPE with stabilizers			
Aluminium	12 micron aluminium			
Coater layer	LDPE with stabilizers			
Reinforcement	PP, 8x8 leno grid			
Bottom side	LDPE with stabilizers, Black			
Colour	Sand/Black			
Application	150 mm overlapping and sealed with double-sided butyl tape or welding.			
Technical data	Unit	Value	Tolerance	Test method
Length	m	25	+1% -0%	EN 1848-2
Width	m	2,034	+1% -0,5%	EN 1848-2
Thickness	mm	0,40	+/- 20%	EN 1849-2
Weight	g/m ²	360	+/- 5%	EN 1849-2
Straightness	Pass/Fail	Pass		EN 1848-2
Visible defects	Visible	No visible defects		EN 1850-2
Tensile strength	N/50mm	MD: > 500		EN 12311-1
		CD: > 450		
Elongation	%	MD: > 15		EN 12311-1
		CD: > 11		
Radon transmittance	10 ⁻⁹ m/s	< 3		SP internal test
Radon permeability	10 ⁻¹² m ² /s	< 1		SP internal test
Methane gas transmission	cm ³ /hm2atm	<0,001		DTI internal test
Sd value	m	>1500m		EN 1931
Water vapour transmission	(m ² .s.Pa)/kg	6,18x10 ⁻¹⁴	4,68x10 ⁻¹⁴	EN 1931
Nail tear resistance	N	MD: > 350		EN12310-1
		CD: > 350		
Resistance to static loading	N	Pass at 200N		EN 12730, Method B
Impact resistance	mm	≥250mm		EN 12691, Method A
Bitumen compatibility	Pass/Fail	Pass class W1		EN 1548
Joint strength tape	N/50mm	57		EN 12317-2
Joint strength welding	N/50mm	320		EN 12317-2
Water tightness to liquid water	kPa	Pass at 2 kPa		EN1928
Durability of water tightness against ageing	kPa	Pass at 2kPa		EN 1296
Durability of water tightness against chemicals	kPa	Pass at 2 kPa	.	EN 1847
Classification	Moisture Barrier Type A – EN 13967			
			Monarflex sro Továrenská 1, SK 943 03 Stúrovo, Slovakia 09 1162-CPD-0254	

Appendix C

PAGeotechnical Supporting documentation

Method statements

Risk Assessments

NVQ Level 2 Gas Installation – Qualification Certificates



METHOD STATEMENT

PROJECT: Glan Gors
Wrexham

CLIENT: Keepmoat

OPERATION: Installation of Gas Barrier

LABOUR/RESOURCE: 1 No 2 Man Team

SITE SUPERVISOR: TBC, NVQ Level 2, QUN 846

DURATION; Based on 3 No plots available per day

START DATE; TBC

COMPLETION DATE: TBC

AREA OF ACTIVITY; All houses and apartments

Keepmoat. Glan Gors, Wrexham

MATERIALS;	Monarflex Reflex Super PAG SAGR Adhesive Gas Membrane
-------------------	--

PAGC Project Manager	Liam Callaghan	07802 742480
PAGC Site Supervisor	Matt Payne	07900 070805
PAGC Director		

PAGeoContracting Ltd.
Darwin House
CorbyGate Business Park
Corby
NN17 5JG

Tel:01536 740040
Fax:01536 740044
Email:office @pageo.co.uk

Document Control

Document reference:	4194/MS
Date of first issue:	16 th April 2014
Status:	
Prepared by:	Liam Callaghan
Revision:	-
Date:	-
Revised by:	-
Date of next revision:	- August 2014 (or earlier if circumstances dictate)

Contents

- 1.0 Introduction
- 2.0 Health and safety considerations and precautionary measures
- 3.0 Operations

Attached

Risk assessments
COSHH risk assessments

1.0 Introduction

This method statement has been prepared to describe the procedures used during general contract works

This method statement must be checked against and using all the latest tender issue drawings and information available.

This document should be read and used in conjunction with the current project risk assessments. An indication of approval of this document, from the Client or client's agent (as applicable), will be required prior to commencement of the works described herein.

Prior to project start-up, Company management will decide on the best sequence of works, and any area / phasing to be incorporated into the works programme.

2.0 Health & Safety considerations and precautionary measures

- a. PAGeoContracting Ltd. is committed to the provision of a safe working environment at all times, and to this end undertake to suitably train and advise staff and operatives as befits their particular role in a project. In addition the company provides, at no cost to the operative, all such protective material and equipment as is necessary to ensure their safety whilst in the company employ.
- b. It is the principal requirement of all contracts that the works and all constituent elements shall comply with the requirements of current health and safety legislation and approved method statements. The details of this statement are supplemental to the articles of current Health and Safety legislation in that they are company specific. However, should there be a conflict of either content or implication, the legislative requirements shall prevail and site practices would be revised to reflect this. Further or revised statements may be required where such an occasion would involve the incidence of an unassessed risk.
- c. This statement shall be issued to operatives and all affected parties so as to inform and advise of the perceived risks and the prescribed preventative measures to be adopted.
- d. When conducting inductions or 'tool-box' talks it is important to ensure that all relevant additional information regarding site or operational restrictions or hazards are suitably relayed to the operatives involved in the works.
- e. It is imperative that all parties are aware of their personal responsibility with regard to their own and others' safety and that they conduct themselves in a manner most likely to fulfil this condition.
- f. The works shall be managed and controlled in such a manner as to minimise or, where possible, eradicate the risk to operatives, interfacing trades or members of the public.
- g. All supervisors, operatives, appointed persons and plant operators shall be trained and certified in accordance with current legislation. Records of such training shall be maintained. Such records will be updated as further training courses are conducted.
- h. The Site Supervisor will assist with the membrane installation, ensure all materials quantities are maintained for each phase of the works, ensure all membrane detailing and sealing details are maintained, to take instruction from site management personnel.
- i. Environmental restrictions shall be adhered to in respect of the management of controlled waste, noise, dust and nuisance. Prior, formal and detailed notices shall be issued where an element of work is anticipated to materially disrupt or affect normal environs.

Keepmoat. Glan Gors, Wrexham

- j. All documentation regarding health and safety, i.e. risk and COSHH assessments, statements etc. are to be retained on site and be made available for inspection at all times.
- k. Changes and unforeseen circumstances may occur throughout the project. In the event of any significant change, the statement should be reviewed and revised where necessary.
- l. All plant and lifting equipment is to have been inspected prior to delivery and be accompanied by the required documentation. Items are to be confirmed as being suitable for the intended use and site checks will be performed to the manufacturer's / supplier's recommendations. Non-conforming items of plant shall be removed from site immediately.
- m. Open excavations shall be fenced off using suitable and sufficient barriers if to be left open whilst unattended to minimise the risk of other operatives falling into it.
- n. A risk assessment will be completed for all work in confined spaces, and only suitably trained operatives may work in confined spaces.
- o. A Permit to Work will be issued for working in confined spaces.
- p. All hot works will be carried out under a permit to work system.
- q. Emergency procedures: Work will stop immediately on hearing fire alarm, with operatives pulling off to a safe distance, or if asked to stop work by site agent/manager or site safety officer. If some one is injured – walking wounded will be escorted to the First Aid point on site or a another person will summon first aid assistance.
- r. All installation operatives/competent persons will receive the site specific Risk Assessments as part of the site installation information to which a signature is required after reading and or adding a site specific observation.
- s. Should the Installation operative/competent person add a note to the Risk assessment, the Site manager will immediately be made aware of his observation.

3.0 Operations

3.1 Site set-up & planning

- a) Confirm full issue of construction status drawings have been received.
- b) All setting out by Keepmoat.

3.2 Loading / unloading / logistics

- a) Identify dedicated pedestrian routes within the works section, and where required, provide a physical barrier from works and plant, using fixed barriers.
- b) Site hours and acceptable delivery times will be agreed. Any restrictions to routes or timing will be noted.

Keepmoat. Glan Gors, Wrexham

- c) A banksman will be required at times, to assist in reversing and unloading deliveries and making sure the public is kept at bay. The site supervisor is to ensure that a banksman is utilized whenever required.
- d) Material delivery and removal is likely to involve a large amount of manual handling. Mechanical lifting and other aids are to be used whenever possible. Site routes are to be kept unobstructed. The site will be organised in such a way that the quantity of manual handling is minimised.
- e) All Gas Membrane materials will be taken to site for each visit in the PAGC company vehicle and unloaded by our operatives.
- f) PAGC company vehicle may be parked on site as required by site conditions.
- g) All operatives will eat and drink in welfare facility provided by Lindum BMS, and ensure Hands are washed at the end of each work period prior to breaks.
- h) PAGC operatives will be available for the Site Induction at 8.00am prompt.

3.3 Preparation

- a) The area to which the membrane is to be installed must be clean and free from all debris and sharp objects. Stones, steps and protrusions/edges must be of a smooth finish and levelled with the appropriate materials.
- b) Where a smooth surface cannot be achieved a protective geotextile membrane may be used before the placement of the final membrane.
- c) All structural works i.e. concrete, brick/block work, cavity fill and column encasement must be complete prior to the commencement of any placement of the membranes. Once membranes are placed and sealed, these seals cannot be broken.
- d) All penetrations to be in place with an upstand of 150mm (MIN) in order to maintain a gas tight seal.

Schedule of Plant & Equipment.

- a) 6KVA Petrol Generator 110v and Drip Tray.
- b) Extrusion Welding Machine 110v.
- c) Leister/Triac Welding machines 110v.
- d) Aqua-Vac 110v.
- e) Scissors.
- f) Hard Hat.
- g) Safety Boots.
- h) Hi Viz Vest
- i) Full Hand Protection.
- j) Safety Glasses

Placement of Monarflex Reflex Super Gas Barrier

- a) The rolls of Monarflex Reflex Super Gas Barrier are in sizes of 2m x 25m rolls weighing approx 25kgs per roll, and will be carried by two competent operatives to the place of work.
- b) The membrane will be cut to the required width and rolled out to the required areas allowing for a step up at the perimeter internal blockwork and face brickwork and dress over the cavity and dress to all party wall level changes as applicable.

Keepmoat. Glan Gors, Wrexham

- c) All membrane overlaps will be 100mm (MIN)
- d) All internal/external corners will be sealed using the SAGR membrane.
- e) The remaining open floor areas will be infilled using the Reflex Super Gas Barrier allowing the barrier to lay beneath the previously installed perimeter barrier and again using overlaps of 100mm (MIN).
The required welding equipment is powered by a 110v Petrol Generator and will be placed on a Drip Tray, on even ground a sensible distance from the work area, the filling of the Generator will be by Jerrican and funnel, with the Jerrican being returned to our company vehicle after use.
- e) The welding machine used for the above process is a Hand Held Leister (Hot Air Fusion) machine and will be operated by a competent person, and an Extrusion Welding Machine for all main site welds, due to the hot extrusion process protective gloves are worn at all times, the machine will be PAT Tested and will have the required tag attached to show the expiry of test period, all associated Extension leads will be checked daily for the Tag and any damage to the lead itself.
- f) Scissors are used to cut and shape the membrane as this is a far safer and accurate method of working.
- g) All penetrations are sealed using the SAGR adhesive Membrane allowing for 150mm to seal vertically and horizontally around the penetration.
- h) Should a penetration be found to be too close to blockwork where the standard sealing detail cannot be achieved, the pipe must be extended above the DPC and lining height by 150mm to allow the SAGR adhesive to change direction around the back of the pipe to ensure a gas tight seal is achieved.
- i) No hot works permit is required for the specified equipment as it does not produce a naked flame.

3.4 Repair or damage

- a) The area of damage should be clean and dry. For areas of damage of less than 150mm in diameter an adhesive patch will be cut at least 200mm larger than the damage.
- b) Backing paper is peeled from the patch and placed over the damaged area with an even pressure applied to ensure a good seal and adhesion.

3.5 Final works

- a) At the end of each stage, the site supervisor will inspect works to ensure compliance with drawings, specification, etc.
- b) Offer completed works for inspection as required by relevant approval bodies, engineer etc.
- c) Tidy up works for completion by fit-out trades.
- d) A hand over certificate will be issued by PAGeoContracting in accordance with their standard procedures.

3.6 Additional Points

- a) The site should be ready for PAGeoContracting to commence works at the agreed time. Any waiting time will be recorded on a day work sheet by the appointed foreman on site and agreed with the Principal Contractors Site Manager. Charges will apply.
- b) On completion of the works and the issuance of the hand over certificate the protection of the membrane becomes the sole responsibility of the Principal Contractor and PAGeoContracting can accept no responsibility for any failure of the membrane due to damage by 'others'.

I Have Read And Understood The Method Statement

PRINT:

SIGNATURE:

PRINT:

SIGNATURE:

Keepmoat. Glan Gors, Wrexham

**Signed by
Author:**

A handwritten signature in black ink, consisting of a stylized 'A' followed by a '2' and a horizontal line.

Risk Assessment.

Deansfield School, Deans Road, Wolverhampton.

Job No: 3910



Page 1 of 3

Environmental

<u>Activity</u>	<u>Environment at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Movement of contaminated product on clothing, boots, plant and equipment	Relocation of product ie Japanese knot weed, oil, petrol to affect un-contaminated environments	New plant grown and damage to property. Endanger other flora and fauna's habitats Cancerogenic / dermatologic consequences with prolonged skin contact	3 x 4 = 12			Cleaning and wash down of equipment following activity on site known to be affected. Use disposable overalls if site conditions stipulate or deemed necessary. Wash working clothing regularly	2 x 3 = 6		
Use of generator for power supply (110V)	Noise pollution. Exhaust fumes. Fuel consumption.	Combustion of fuel source. Noise and exhaust pollution	3 x 5 = 15			Locate in a well-ventilated area and use LEV to direct fume to a safe outlet. Minimise running times and observe permitted working times. Refuel in allocated areas using drip trays and a funnel. Refuel from a designated fuel can. No smoking/naked flames. Ensure plant is serviced to manufacturer's guidelines	2 x 3 = 6		

						and inspected prior to use.			
<u>Activity</u>	<u>Environment at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			<u>L</u>	<u>C</u>	<u>R L</u>		<u>L</u>	<u>C</u>	<u>R L</u>
Disposal of Bitumen based primers, silicon sealants and mastics.	Impact to ground conditions and /or watercourse	Combustion of product or misused and burnt. Ground contamination.	4	x	4 = 16	Store product as guidance under COSHH. Maintain clean work area. Use warning notices or cordon off work area/skips to restrict direct contact. Disposal in accordance with local authority guidelines. Operate spill protection measures and have spill kits available for such events.	2	x	3 = 6

<u>Activity</u>	<u>Environment at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Driving to/from site	CO2 pollution	Global warming	5 x 5 = 25			Minimise journeys, reduce vehicle weight, and drive within speed limits. Use alternative means if appropriate or vehicle share.	4 x 3 = 12		
Disposal of packaging and wrapping		Littering. Endanger wildlife	4 x 4 = 16			Disposal in accordance with local authority guidelines and site guidance if applicable. Ensure small items are bagged to prevent being blown out of skips. Recycle products identified by the manufacturer. Good housekeeping.	3 x 2 = 6		

Likelihood (L) = Frequent,5 / Probable,4 / Occasional,3 / Improbable, 2 / Remote, 1

Consequence (C) = Catastrophic, 5 / Major, 4 / Moderate, 3/ Minor, 2 / Insignificant, 1

Risk Level (RL) = 17 -25 Take action immediately / 10 – 16 Tolerable / 5 – 9 Adequate / 1 – 4 Acceptable

Assessment by; Neil Salvidge

Date: 2013

Position: Training Manager

Review Date: June 2014

Risk Assessment.

Deansfield School, Deans Road, Wolverhampton. Job No: 3910



Page 1 of 4

General Workplace Activity.

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
General site attendance	PAG operatives	Plant movements resulting in crushing or impact injuries.	4	x	5 = 20	Comply with site traffic management systems; adhere to appointed Banksman's instruction when vehicle movements are in progress. Use designated pedestrian walkways. Wear Hi Viz PPE	3	x	4 = 12
General site attendance	PAG operatives. Other site operatives	Dust & fibre particles, smoke and fume inhalation causing breathing/ respiratory conditions .	4	x	5 = 20	Use approved PPE & RPE (see H&S Policy) and LEV, attend training/tool box talks when conditions arise. Comply with SSW and permit to work controls.	3	x	4 = 12
General site attendance	PAG operatives	Unstable walking/working platform. Poorly installed sub base. Potential of falling through voids	4	x	4 = 16	Visual inspection prior to entering the area. Complete sub base inspection formalities and report fail points. Do not proceed until correct. Remain on known surfaces	3	x	3 = 9

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
General site attendance	PAG operatives	Extreme weather conditions, from sun, rain, wind, frost resulting in sun burn, MSD from cold/wet exposure, lack of dexterity in frost.	4	x	5 = 20	Use approved PPE (see H&S Policy), take breaks to recover body warmth, rehydrate as guided by medical advice, apply sun screen. Attend tool box talks	3	x	3 = 9
General Site attendance	PAG operative	Airborne particles resulting in eye injuries.	4	x	5 = 20	Use approved PPE under H&S Policy that is maintained to a recommended standard and stored in accordance with manufacturer's instructions.	2	x	3 = 6
General site attendance	PAG operatives	Poor personal hygiene and possible infection transmission from hand to mouth/objects contact.	4	x	4 = 16	Wear gloves to reduce contact with dirty environments, apply barrier cream prior to work and wash hands thoroughly at the end of every working period and/or before urinating, eating & drinking.	2	x	2 = 4

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
General site attendance	PAG operatives	Contact with contaminants (water/ground conditions/vermin/waste products)	3 x 4 = 12			Uses approved PPE & RPE as guided under H&S policy, and insure any prior skin cuts are covered with waterproof dressing. Follow good hygiene practice as stated above.	2 x 3 = 6		
General site attendance	PAG operatives	Working below other trades.	3 x 5 = 15			Attend daily work planning meeting if conducted. Plan access and exit to work areas to avoid trades above. Avoid working under other trades unless a safety net / debris barrier is installed.	2 x 4 = 8		
General site attendance	PAG operative	Individual working.	4 x 5 = 20			Comply with site induction and signing in and out register. Notify line manager and on site manager of your activity. Implement a SSW for individual working with checks and reporting in.	3 x 4 = 12		

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
General site attendance	PAG operative	Difficult site conditions underfoot. Mud, rutted, icy, waterlogged, slopes. Potential slip, trips and falls	3	x 4	= 12	If conditions restrict / limited regular walking, and pathway is not visible do not proceed. Use signposted routes and appointed walkways	2	x 2	= 4

Page 4 of 4

Likelihood (L) = Frequent, **5** / Probable, **4** / Occasional, **3** / Improbable, **2** / Remote, **1**
Consequence (C) = Catastrophic, **5** / Major, **4** / Moderate, **3** / Minor, **2** / Insignificant, **1**
Risk Level (RL) = **17 -25 Take action immediately** / **10 – 16 Tolerable** / **5 – 9 Adequate** / **1 – 4 Acceptable**

Assessment by; Neil Salvidge

Date: 2014

Position: Training Manager

Review Date: June 2014

Risk Assessment.

Deansfield School, Deans Road, Wolverhampton.

Job No: 3910



Page 1 of 2

Manual Handling.

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Moving Loads	PAG operatives	Incorrect lifting technique (lifting, pulling, pushing, holding, reaching, carrying, twisting, lowering, standing)	4	x	4 = 16	Training on manual handling and refresh when needed or job changes via Tool box talks.	3	x	2 = 6
Moving Loads	PAG operatives	Weight and size of load is excessive leading to MSD (Musculoskeletal disorders)	4	x	4 = 16	Break weight into smaller denominations, use mechanical aids, seek assistance with additional operatives	3	x	2 = 6
Moving Loads	PAG operatives	Uneven surfaces resulting in slips, trips and falls	4	x	4 = 16	Check route to be taken is clear of debris and obstructions. Reduce time carrying load and take rests between loads.	3	x	2 = 6
Moving Loads	PAG operatives	Falling Loads of stacked material.	4	x	3 = 12	Secure loads with strapping on sound level surface. Use appropriate PPE	3	x	2 = 6

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			<u>L</u>	<u>C</u>	<u>RL</u>		<u>L</u>	<u>C</u>	<u>RL</u>
Mechanical moving of loads	Plant operator PAG operative Banksman	Crushing by moving plant, falling or swinging load.	4	x	4 = 16	All loads to be slung by an appointed person. Use suitable lifting aids that have been inspected. Wear appropriate PPE during lifting. Plant movement directed by appointed Banksman.	3	x	3 = 9
Mechanical moving of plant	PAG operatives	Failure of lifting aids leading to falling of loads and crushing	4	x	4 = 16	All loads to be slung by an appointed person. Use suitable lifting aids that have been inspected. Wear appropriate PPE during lifting.	3	x	3 = 9
General lifting operations	PAG operatives Assisting operatives	An operative's general health must be considered which could be affected by manual handling operations.	3	x	4 = 12	Prior assessment/health monitoring of operatives. Manual handling refresher/tool box talks when situations are identified.	2	x	2 = 4

Page 2 of 2

Likelihood (L) = Frequent, 5 / Probable, 4 / Occasional, 3 / Improbable, 2 / Remote, 1

Consequence (C) = Catastrophic, 5 / Major, 4 / Moderate, 3 / Minor, 2 / Insignificant, 1

Risk Level (RL) = 17 - 25 Take action immediately / 10 – 16 Tolerable / 5 – 9 Adequate / 1 – 4 Acceptable

Assessment by; Neil Salvidge

Date: 2014

Position: Training Manager

Review Date: June 2014

Risk Assessment.

Deansfield School, Deans Road, Wolverhampton.

Job No: 3910



Page 1 of 4

Operational Tasks

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Manual cutting of membranes/textiles using scissors	PAG operatives	Cuts or punctures to skin	3	3	9	Use approved hand protection in accordance with PAGC H&S policy. Use and store scissors as guided in training.	1	3	3
Mechanical cutting	PAG operatives	Cutting of skin. Electric shock. Inhalation/eye impact of waste product	3	4	12	Operate cutting device in accordance with manufactures guidelines and training. Adhere to PAGC H&S policy guidelines to hand, RPE and eye protection. Insure plant carries valid PAT cert, use RCD on 110v supply	2	4	8
Using Twinny welding systems	PAG operative	Burns to operator operator's skin & other close proximity trades. Fumes. Combustion and fire. Electric shock. Crushing of fingers in feed rollers.	3	4	12	Operate as trained and specified by manufacturer. Insure plant carries valid PAT cert, use RCD on 110v supply. Adhere to site specific Hot works SSW. Maintain clean work area. Use warning notices or cordon off work area to restrict direct contact.	1	4	4

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Using Triac Heat Gun and Extrusion welders	PAG operatives	Burning of operator's skin & other close proximity trades. Fumes. Combustion and fire. Electric shock	4 x 4 = 16			Operate as trained and specified by manufacturer. Insure plant carries valid PAT cert, use RCD on 110v supply. Adhere to site specific Hot works SSW. Maintain clean work area. Use warning notices or cordon off work area to restrict direct contact.	2 x 4 = 8		
Drilling	PAG operatives	Vibration, dust/ particle inhalation, eye impact, noise. Electric shock	4 x 4 = 16			Monitor / assess timing of task to minimise exposure. Use PPE as approved under H&S Policy. . Ensure plant carries valid PAT cert, use RCD on 110v supply.	2 x 4 = 8		
Electrical supply to power tools (110v)	PAG operatives	Electric shocks	3 x 4 = 12			Use appointed site power source if available. Gain permission to connect. Ensure plant and extension leads carry valid PAT cert, use only 110v supply on RCD. Carry out visual inspections of appliances prior to use	1 x 3 = 3		
Use of generator for power supply (110V)	PAG operative Other site operatives	Electric shocks. Combustion of fuel source. Noise and exhaust pollution	3 x 5 = 15			Locate in a well-ventilated area and use LEV to direct fume to a safe outlet. Minimise running times and observe load rating. Refuel in allocated areas using drip trays/bunds and a funnel. Refuel from a designated fuel can. No smoking/naked flames. Ensure plant is serviced to manufacturer's guidelines and visual inspection prior to use.	2 x 3 = 6		

Activity	Persons at Risk	Hazards	Risk			Control Measures	Residual Risk		
			L	C	R L		L	C	R L
Using LPG flame sources	PAG operative	Burns, combustion, fumes	3 x 5 = 15			Maintain clean work area. Use warning notices or cordon off work area to restrict direct contact. Operate to site specific hot works SSW and have fire fighting measures or fire plan in place as of the SSW. Only use trigger active torches, minimising time of flame ignition. Store LPG bottles under COSHH guidelines.	2 x 3 = 6		
Using Bitumen based primers, silicon sealants and mastics.	PAG operative	Skin contact irritation, ingestion, eye contact, combustion.	4 x 4 = 16			Observe PAGC H&S policy to specific PPE & PRE measures. Store product as guidance under COSHH. No smoking and observe good hygiene practice after use. Maintain clean work area. Use warning notices or cordon off work area to restrict direct contact.	2 x 3 = 6		
Deploying membrane / holding down systems	PAG operatives Other site trades General public	Airborne sections of material in high wind causing whipping, striking injuries	4 x 4 = 16			Do not deploy in high wind or gusty conditions. Allocate and position holding down materials, complete TBT of operational procedures prior to deployment of membrane	2 x 3 = 6		
Working on sub base formation. Block and beam, sand blinded and membranes	PAG operatives	Falling through voids, slipping and tripping	3 x 4 = 12			Visual inspection of sub base prior to accessing. Identify variations in levels, inspection chambers, edges and thickenings and cordon off. Observe warning signs and barriers. Assess membrane suitability for access in wet or icy weather and ensure SSW are observed.	1 x 3 = 6		
Page 3 of 4									

<u>Activity</u>	<u>Persons at Risk</u>	<u>Hazards</u>	<u>Risk</u>			<u>Control Measures</u>	<u>Residual Risk</u>		
			L	C	R L		L	C	R L
Fixing and handling GRP battening	PAG operatives	Skin irritation and/or splinters from GRP. Dust inhalation	4 x 3 = 12			Observe PAGC H&S policy to hand and eye protection measures. Ensure LEV	1 x 2 = 2		

Likelihood (L) = Frequent, **5** / Probable, **4** / Occasional, **3** / Improbable, **2** / Remote, **1**

Consequence (C) = Catastrophic, **5** / Major, **4** / Moderate, **3** / Minor, **2** / Insignificant, **1**

Risk Level (RL) = **17 -25 Take action immediately** / **10 – 16 Tolerable** / **5 – 9 Adequate** / **1 – 4 Acceptable**

Assessment by; Neil Salvidge

Date: 2014

Position: Training Manager

Review Date: June 2014



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

**City &
Guilds**

This
Cskills Awards
Level 2 NVQ Diploma
in

**Sub-structure Work Occupations (Construction) -
Installation of Gas Membranes (QCF)**

(600/3747/7)

is awarded to

Gary Carey

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Regulated by

Ofqual
REGULATED

For more information see <http://register.ofqual.gov.uk>

Issued Date: 23-04-2013

1624966

Registration No: 4435499



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

**City &
Guilds**

This
Credit Certificate

is awarded to

Gary Carey

- | | |
|---------|---|
| Level 1 | Conforming to General Health, Safety and Welfare in the Workplace |
| Level 2 | Conforming to Productive Working Practices in the Workplace |
| Level 2 | Installing Gas Membranes in the Workplace |
| Level 2 | Moving, Handling and Storing Resources in the Workplace |
| Level 2 | Preparing to Install Gas Membranes in the Workplace |

A/503/1170	2 credits
J/503/1169	3 credits
L/601/6666	18 credits
F/503/1171	5 credits
R/601/6653	13 credits

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Regulated by

Ofqual
OFQUAL

For more information see <http://register.ofqual.gov.uk>

Issued Date: 23-04-2013

1624965

Registration No: 4435499



P.A.
GEO



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

City &
Guilds

This

Cskills Awards

Level 2 NVQ Diploma

in

**Sub-structure Work Occupations (Construction) -
Installation of Gas Membranes (QCF)**

(500/9027/6)

is awarded to

Matthew Payne

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Ofqual
.....

Issued Date: 12-12-2011

1352838

Registration No: 1836683

Cskills Awards provides qualifications, assessment and training support services and is a division of ConstructionSkills



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

City &
Guilds

This

Credit Certificate

is awarded to

Matthew Payne

Level 2	Conforming to Efficient Working Practices in the Workplace	J/600/7139	3 credits
Level 1	Conforming to General Safety in the Workplace	F/600/7138	2 credits
Level 2	Installing Gas Membranes in the Workplace	L/601/6666	18 credits
Level 2	Moving and Handling Resources in the Workplace	J/600/7142	5 credits
Level 2	Preparing to Install Gas Membranes in the Workplace	R/601/6653	13 credits

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Ofqual

Issued Date: 12-12-2011

1352837

Registration No: 1836683

Cskills Awards provides qualifications, assessment and training support services and is a division of ConstructionSkills

P A GEO
Cont



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

City &
Guilds

This
Cskills Awards
Level 2 NVQ Diploma
in

**Sub-structure Work Occupations (Construction) -
Installation of Gas Membranes (QCF)**

(500/9027/6)

is awarded to

Richard Grady

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Ofqual

Issued Date: 12-12-2011

1352842

Registration No: 2538984

Cskills Awards provides qualifications, assessment and training support services and is a division of ConstructionSkills



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

**City &
Guilds**

This
Credit Certificate

is awarded to

Richard Grady

Level 2	Conforming to Efficient Working Practices in the Workplace	J/600/7139	3 credits
Level 1	Conforming to General Safety in the Workplace	F/600/7138	2 credits
Level 2	Installing Gas Membranes in the Workplace	L/601/6666	18 credits
Level 2	Moving and Handling Resources in the Workplace	J/600/7142	5 credits
Level 2	Preparing to Install Gas Membranes in the Workplace	R/601/6653	13 credits

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

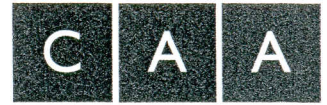
Ofqual
.....

Issued Date: 12-12-2011

1352841

Registration No: 2538984

Cskills Awards provides qualifications, assessment and training support services and is a division of ConstructionSkills



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

City&
Guilds

This

Cskills Awards

Level 2 NVQ Diploma

in

**Sub-structure Work Occupations (Construction) -
Installation of Gas Membranes (QCF)**

(500/9027/6)

is awarded to

Stephen Benson

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Ofqual
OFQUAL

Issued Date: 22-05-2012

1414063

Registration No: 1478541



Construction Awards Alliance

Construction Awards Alliance is an alliance
between Cskills Awards and City & Guilds

cskills
awards

City&
Guilds

This

Credit Certificate

is awarded to

Stephen Benson

Level 2	Conforming to Efficient Working Practices in the Workplace	J/600/7139	3 credits
Level 1	Conforming to General Safety in the Workplace	F/600/7138	2 credits
Level 2	Installing Gas Membranes in the Workplace	L/601/6666	18 credits
Level 2	Moving and Handling Resources in the Workplace	J/600/7142	5 credits
Level 2	Preparing to Install Gas Membranes in the Workplace	R/601/6653	13 credits

Adrian Beckingham
Head of Cskills Awards

Chris Jones
Director General
The City & Guilds of London Institute

Ofqual
OFQUAL

Issued Date: 22-05-2012

1414062

Registration No: 1478541

Appendix E

Copy of MEC Environmental Validation/Integrity Plan



GAS PROTECTION VALIDATION/INTEGRITY TESTING PLAN

MEC Environmental Ltd

Company No: 06986903

Copyright Clause

The material contained within these pages is the sole property of MEC Environmental Ltd. All rights to copy the material contained within these pages are reserved.

Any user may receive, store and distribute copies of the material contained within these pages in purely electronic form, including on computer networks, computer bulletin board systems, computer conferencing systems and organisational computers, provided, and only provided, that:

- i. All material contained within these pages, including this notice, are not altered in any manner;
- ii. No profit or payment of any kind is charged for the usage and/or distribution of any material contained within these pages; and
- iii. You may not otherwise copy, reproduce, recompile, decompile, disassemble, reverse engineer, distribute, publish, display, perform, modify, upload to create derivative works from, transmit or in any way exploit any part of this plan. All proprietary rights remain the property of the Company
- iv. The material contained within these pages is not reproduced nor distributed in printed or paper form, nor on CD-ROM, nor in any form other than the electronic forms described above, without prior written permission from MEC Environmental Ltd.

1. INTRODUCTION

1.1 Purpose

MEC Environmental Ltd (MEC) has been appointed by to carry out independent validation and integrity testing to the installation of the membrane on the site by . This plan sets out the requirements and procedures that will be adopted by MEC and others in respect of fulfilling the obligations of its appointment.

1.2 Limitations

(MEC) has prepared this plan in accordance with the terms of its appointment for the gas membrane integrity testing and validation/inspections and report.

This plan is limited to setting out the procedures that (MEC) will adopt under its appointment as Validators for the Gas Membrane Installation as well as highlighting good practises for installing gas barriers. The does not in itself constitute verification that the gas membrane has been installed in accordance with this document. A separate validation report will be issued by (MEC) upon successful completion of the installation, furthermore (MEC) have not carried out any site classification work in respect of the gas protection measures prescribed for this site or reviewed any site investigation/gas monitoring or verification strategies compiled by others and therefore no professional liability is extended in respect of the risks on site.

This validation plan and its contents should not be used for any purpose other than that for which it was prepared and provided. Should the Client require to pass copies of the report to other parties for information, the whole of the plan should be so copied.

2. Risk Assessment

2.1 Site Background

3. Submissions

3.1 Design Drawings

An up to date copy of the construction drawings for gas protection measures shall be kept on site by the Principle Sub-Contractor responsible for this element of the works, these shall be made available to the Validation Consultant on request.

Site specific, annotated details relating to stanchions, wind braces, pipe penetrations etc. are to be produced by others and agreed prior to commencing the gas protection element of the work

3.2 Delivered Materials

The Gas Membrane Installer shall supply the Validation Consultant with a copy of all signed delivery notes for the gas membrane and all associated accessories, The Validation Consultant will acknowledge receipt of the above in the site inspection sheets section of the final validation report. Where these are not available, the Validation Consultant will take photos of the products and a selection of these shall be included in the site inspection section of the final validation report.

4. Earthworks

4.1 Subgrade Preparation

Given there are two separate types of slab being used with these houses the Subgrade preparation will be the following:

Block and Beam Floor Slab

The membrane will be placed on the block and beam prior to the finishing screed.

The Gas Membrane Installer will verify that:

- The floor slab is suitably finished so not to create damage to the membrane prior to installation of the gas membrane.

The Installer will certify in writing to the Validation Consultant that the slab on which the gas membrane will be installed within the next 24 hours is acceptable. The Installer will also give the certificate of acceptance (see Appendix A), to a nominated representative from the Groundworks Contractor prior to commencement of the gas membrane installation in the area under consideration.

After the slab has been accepted by the Gas Membrane Installer, it will be the Installer's responsibility to indicate to the nominated representative of the Groundworks Contractor any change in the slab condition that may require repair work.

Where a dispute arises the Validation Consultant's decision will be final and the Groundworks Contractor will ensure that the slab is repaired at the Groundworks Contractors cost.

The Validation Consultant will then re-inspect the slab along with a representative from the Installer and the Groundworks Contractor.

5. Seam Planning

5.1 Seam Location

Horizontal seams in loose laid membranes should not be made across changes in grades such as batters or the like, or on vertical surfaces such as retaining walls or external masonry walls etc. Seams in these areas should run parallel to the slope of the grade or vertical surface i.e., oriented up and down, not across, the slope/surface. In corners and other geometrically complex locations, the number of seams should be kept to a minimum. No base seams or tee seams will be less than 100mm from the top or base of changes in grade or vertical surfaces.

6. Installation

6.1 Temporary Restraint

The Installation Companies Supervisor will monitor the placement of the gas membrane and subgrade to confirm that the gas membrane is in reasonable contact with the subgrade, and adequately weighted down, without excessive tension, in areas not covered at the end of each working day.

6.2 Installation Schedule

The rolls of gas membrane will be placed one at a time, and each panel or roll will be seamed as soon as possible after placement.

Adhesive Compression Strips for Detailing or preformed Pipe Penetrations and the like should be installed after the placement and seaming of each panel/roll as far as is as is reasonably practical. However the sequencing of this is the responsibility of the installer.

6.3 Weather Conditions

Gas membrane placement shall not take place during any precipitation, in an area of ponded water, or during excessive winds etc.

The recommended maximum and minimum installation temperatures quoted on material manufacturers data sheets should be adhered to at all times. Special attention should be given to bitumen and butyl type self adhesive products (tape jointing or detailing work) as in most cases these will have the lowest installation temperature range.

Placement of the gas membrane should not take place in any event when the temperature is below zero degrees, as this will present a health and safety risk to site personnel, in these conditions the gas membrane surface will become too dangerous to walk on.

When laying the gas membrane it is beneficial to proceed in the direction of (with) the prevailing winds. This decision must be made during installation, in accordance with varying environmental conditions. In any event, the Installer will be fully responsible for the decisions made regarding placement procedures.

6.4 Damage

The Installation Companies Supervisor will visually examine the gas membrane and details (pipe penetrations, stanchions etc), after placement and seaming, for damage. Damaged areas, will be repaired in accordance with the procedures described in Section 6.

As a minimum, the Installation Supervisor will ensure that:

- The membrane is placed in such a manner that it has not been, or is unlikely to be, damaged; and
- Any tears, punctures, holes, thin spots, gouges, and protuberances etc., are marked for repair, repairs will be made according to procedures described in Section 6.

6.5 Seaming Equipment

Approved methods for field seaming are thermal fusion (hot wedge, hot air, or a combination of both) or Double Sided Tape. Any alternative methods will be documented and submitted to the Validation Consultant for approval.

Fusion seaming may be done with either automated self-propelled machines i.e. Leister Twinny S or similar, or alternatively with hot air guns i.e. Leister Triac S or similar.

6.5.1 Automatic Thermal Fusion

Automatic fusion seaming machines will be equipped so that temperature, speed, and roll pressure settings can be adjusted to ensure the optimum weld is achieved. The correct settings will be dependent on the climatic conditions encountered and the type of material to be installed.

6.5.2 Manual Thermal Fusion

Manual fusion seaming (Hand Welding) 110v hot air guns should be fitted with a potentiometer so that the temperature and flow of air directed to the gas membrane can be adjusted to ensure that the optimum weld will be achieved. The correct settings will be dependent on the climatic conditions

encountered and the type of material to be installed

For Manual fusion seaming joints, silicone seam rollers should be used, except in areas such as corner detailing where a steel penny roller will be required. Hand welded joints should not be formed using metal rollers as they will become hot and may damage the upper surface of some gas membranes. Plastic Seam rollers should not be used in any situation where hot air will be present.

6.5.3 Adhesive Compression Joints

Adhesive Compression Joints consist of single or double-sided jointing tapes, tanking detailing strips and sheets. Adhesive Tapes, Strips and Sheets require heating prior to laying, moisture may also need to be removed prior to the laying of the strips to the lower sheet of gas membrane. Therefore a 110v hot air gun fitted with a potentiometer so that the temperature and flow of air directed to the lower sheet of gas membrane can be adjusted to ensure that the optimum adhesion will be achieved.

All adhesive compression joints should be made with hand held silicone roller (min girth 20mm) and steel penny roller.

6.5.4 General Equipment

The Installer shall maintain as a minimum the following serviceable equipment throughout the duration of the installation:

- 110v Automated Fusion Seam Welder (Only When Automated Fusion Welding is being carried out)
- 110v Hot Air Gun with Potentiometer and a selection of air nozzles, typically 40 – 20mm
- Hand Held Silicone Seam Roller
- Hand Held Penny Roller
- 50mm Paint Brush
- Hand Held Wire Brush
- Gas Membrane/Peel & Stick Shears/Scissors
- Craft Knife with Retractable Blades
- Long Handled Stiff Broom/Brush
- A smooth insulating plate or fabric for placing beneath the hot seaming apparatus after usage
- An electric generator/generators capable of powering the above equipment
- Any equipment identified as necessary by the installer after risk assessment to fulfil its Health & Safety Obligations i.e. P.P.E.

6.6 Trial Seams(Thermal Fusion Seams)

Trial seams will be made on strips of gas membrane to verify that seaming can be successfully performed. Such trial seams will be made at the beginning of each seaming period. In addition, a new trial seam will be conducted when a welding apparatus has been restarted after being switched off. A trial seam will also be made in the event that the ambient temperature changes more than 10°C since the last trial seam. Trial seams will be made under the same conditions as production seams will be made. In general, trial seams will be conducted as follows:

The trial seam sample will be at least 500mm long by 300mm wide with the seam centred lengthwise. Seam overlap will be a minimum 70mm. The Validation Consultant will inspect trial seams and this will be recorded in the final validation report. Where trial seams have not been made the validation consultant shall mark several areas at his discretion for destructive testing. A 50mm wide strip of membrane perpendicular to the direction of the joint shall be cut out. The Validation Consultant will then perform a “wishbone” test to the joint.

6.7 Thermal Fusion Seaming Procedure

Unless detailed elsewhere, the thermal fusion seaming procedure used by the Installer will be as follows:

- A movable protective layer of plastic (sledge) may be placed directly below each overlap of gas membrane that is to be seamed. This is to help prevent any moisture build-up between the sheets to be seamed;
- If required, a firm substrate may be provided by using a flat board, or other similar hard surface placed directly under the seam overlap;
- A Roll or prefabricated panels of gas membrane will be rolled or pulled out onto the pre-approved subgrade and trimmed to size, ensuring that contact with the subgrade is achieved. The membrane should be fully supported by the subgrade with no areas bridging changes in grade.
- The next roll of membrane should follow the same the procedure, ensuring that a minimum **70mm overlap** is achieved.
- The membrane overlaps will then be thermally fused together using either an automated fusion seam welder or hand held fusion welder and silicone roller, either method should achieve a minimum **25mm wide** solid seam between the two sheets.
- Fishmouths or wrinkles at the seam overlaps will be cut along the peak of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed and any portion where the overlap is inadequate will then be patched with an oval or round patch of the same gas membrane material extending a minimum of 150 mm beyond the cut in all directions. The end of the cut should be rounded;

6.8 Self Adhesive Detailing Procedure

Unless detailed elsewhere, the compression seaming procedure used by the Installer will be as follows:

- Sheets of single or double sided self adhesive jointing or detailing strips will be overlapped onto gas membrane to be sealed, by a minimum of 75mm.
- Adjacent Sheets of self adhesive joint/detailing strips will be overlapped with each other by a minimum of 25mm and smoothed with a hand held silicone roller.
- Any Fishmouths or wrinkles on any given joint shall be removed and discarded and replaced with a new strip of material.

7. Validation Procedures

7.1 Inspection Schedule

No covering such as reinforcement steel, insulation etc shall be laid until the area under consideration has been fully inspected and signed off by the validation consultant. For programming purposes approx. 8 hours should be allowed from completion of the installation of the membrane for inspection/integrity testing and remedial works to be carried out.

7.2 Field Seams (per visit)

The Validation Consultant will visually inspect and then non-destructively test all pipe penetrations, stanchion flashings and corner details as these are the critical areas for gas migration into buildings, furthermore the Validation Consultant will non destructively test a minimum of 100% of seams over their full length using a Air Lance Test to ASTM D4437. Any defects will be repaired and recorded as per section 6.3 & 6.2 respectively. The purpose of this method of non-destructive testing is to check the continuity of seams and details only.

The Validation Consultant will:

- Perform all non-destructive testing;
- Mark on the gas membrane the date and outcome (Pass/Fail) of all testing and photograph for inclusion in the final validation report
- Verbally Inform the Installation Contractor of any required repairs.
- The Installer will complete any required repairs in accordance with Section 6.

- Observe the repair and re-testing of the repair;
- Mark on the gas membrane that the repair has been successfully made and tested, photograph for inclusion in the final validation report
- Undertake a visual inspection of non seamed areas

7.2.1 Equipment

- Petrol Generator
- 110v Air Compressor capable of maintain 3.5bar continuous outlet pressure.
- Air Lance with 5mm outlet nozzle and associated air hose.

7.2.2 Method

This test method shall be used as a non-destructive test measure of the seams and to also identify areas of defects in detailing areas, the test will be carried out as follows

- The Validation Consultant will visually inspect all areas detailed in section 5.1
- Compressed air will be dispersed from the air lance at a rate max 3.5bar minimum 2.5bar at the seam, the air lance will be positioned within 50mm of the seams, the test shall proceed at a rate not exceeding 20lm a minute. The procedure shall not puncture or otherwise damage the sheet material. Perform air lancing only after the seam has had sufficient time to cure as per (ASTM D 4437)
- The results of the test will recorded as per section 5.1.

8. Defects and Repair

8.1 Identification

All seams and non-seam areas of the gas membrane will be integrity tested as per 5.1 & 5.2 by the Validation Consultant for identification of defects, protruding and penetrating objects, lack of subgrade support, overheating, holes, blisters, un-dispersed raw materials, scratches and gouges, and any sign of contamination by foreign matter. To facilitate the examination the gas membrane surface will be kept clean by the Installer (or as agreed at the Preconstruction Meeting).

8.2 Evaluation

In areas that fail the non-destructive testing or visual inspection, the Validation Consultant will mark and date the gas membrane adjacent to the defect and the Installer will then repair this. Work will not proceed with any materials which will cover locations that have been repaired until the Validation Consultant has re-marked the repair with the date and word Pass, and taken photographs, a sample of which will be included in the final validation report.

8.3 Repair Procedures

Any portion of the gas membrane exhibiting a flaw, or failing a visual inspection or non-destructive test, will be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure will be agreed upon between the Validation Consultant and the Installer.

The procedures available include:

- Self adhesive patching, used to repair all penetrating holes, tears, un-dispersed raw materials, and contamination by foreign matter;
- Capping with a strip of gas membrane, used to repair long lengths of failed seams.

In addition, the following provisions will be satisfied:

- All surfaces must be clean, free of all particulate matter, and dry at the time of the repair;
- All seaming equipment used in repairing procedures must be approved;
- The repair procedures, materials, and techniques will be approved in advance of the specific repair by the Validation Consultant;
- Patches and caps will extend at least 150 mm beyond the edge of the defect, and all corners of patches will be rounded with a radius exceeding 15 mm;
- Sharp ends of slits and cuts in the gas membrane should be rounded before patches are placed over them;

8.4 Verification of Repairs

Each repair will be non-destructively tested using the methods described in Section 5.1 Or 5.2 or another approved method. Repairs passing the non-destructive test will be considered acceptable. Failed tests will require the repair to be redone and retested until a passing test results. The Validation Consultant shall carry out all non-destructive testing of repairs and will mark the date of the repair and test result on the gas membrane, prior to taking photographs, a sample of which will be included in the final validation report.

9.0 Validation Report

Separate validation reports will be produced by MEC Environmental Ltd on completion of the installation and submitted to the client, the report will take the format of MEC Environmental Ltd's standard gas membrane validation report and will contain the following information as a minimum.

- Reference/Name of Job
- Scope of Work Undertaken (as per this document)
- Inspection Survey Sheets for All site Visits
- Manufacturer's membrane product technical specification sheet(s)
- Copies of the Installers Certificate of Subgrade Acceptance
- Records of all non destructive quality control tests and apparent failures

APPENDIX A
(Subgrade acceptance form)

SUBGRADE SURFACE ACCEPTANCE

PROJECT: _____ JOB NUMBER: _____ LOCATION: _____
DATE: _____

I, the undersigned duly authorised representative of (installer), certify that upon visual inspection, the sand blinding surface meets the criteria for the installation of a proprietary gas membrane. By signing below, however, (installer) acknowledges no responsibility for the subgrade design, elevation, or maintenance thereof, in any way.

Approximate size of area: _____ m²

Description of area:

Signed on behalf of Installer: _____

Print Name:

Date:

Signed on behalf of Earthwork Contractor: _____

Print Name:

Date:

Appendix F

BH Constraints Drawing 6503-131

