Standardised NTS Minimum Offtake Connections in Pits

Innovation Project

Detailed Design Report

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Abbreviations

AGI	Above Ground Installation
BOD	Basis of Design
BS	British Standard
CDS	Conceptual Design Study
CP	Cathodic Protection
DP	Design Pressure
ECV	Emergency Control Valve
EJP	Engineering Justification Paper
FPSA	Formal Process Safety Assessment
ICF	Incomplete Combustion Factor
IGT	Independent Gas Transporter
IJ	Insulation Joint
LOV	Locally Operated Valve
MIP	Maximum Incidental Pressure
MOC	Minimum Entry Connection
MOC	Minimum Offtake Connection
MOP	Maximum Operating Pressure
NB	Nominal Bore
NGT	National Gas Transmission
NIA	National Innovation Allowance
NTS	National Transmission System
PFC	Parallel Flange Channel
RTJ	Ring Type Joint
SI	Sooting Index
SME	Subject Matter Expert
UNC	Uniform Network Code
WN	Wobbe Number

Executive Summary

This report presents the research, development and detailing of a design for a standardised, pit-based Minimum Offtake & Entry Connections (MOC) suitable for entry or exit connections for greenfield biomethane customers to connect to the National Transmission System (NTS). The solution has been developed as part of an innovation project to provide a low-impact, cost-effective alternative to traditional Above Ground Installations (AGIs), significantly reducing site footprint, visual impact, planning complexity, and construction effort while maintaining full compliance with National Gas technical, safety, and operational requirements.

The design accommodates both 80mm Nominal Bore (NB) and 100mm NB connections within a single standardised pit arrangement and is suitable for entry and exit connections at NTS pressures up to 94 barg. A shallow, wide pit geometry with a 3000mm x 2000mm clear opening and 600mm internal depth has been adopted whilst addressing historic issues associated with legacy valve pits, including corrosion at wall transitions, flooding, poor access, and confined space risks.

Security, hazardous area classification, corrosion protection, access, and maintenance requirements have been fully integrated into the design. The pit is secured using SR3-rated access covers, with ventilation and gas monitoring procedures aligned with National Gas operational practices. The civil design has been developed around a precast concrete chamber solution to enable off-site fabrication, accurate integration of access covers, steps, and lifting points, and minimal on-site construction activities.

The mechanical design includes a main isolation valve, bypass valve, vent, purge and pressure gauge connection valves to facilitate commissioning, operations and maintenance activities required of any National Gas MOC. The pipework arrangement can be fabricated and tested in workshop conditions and delivery to site in one piece, reducing on-site construction activities further.

The standardised approach offers clear lifecycle benefits, including reduced design effort at application stage, shorter programme durations, improved cost certainty, and enhanced constructability, while retaining flexibility for site-specific adaptations where necessary. The design is intended to be deployed subject to specific project location meeting defined prerequisites presented in this report.

This report documents the technical basis, assumptions, calculations, and decisions underpinning the final design and is submitted to support acceptance of the standard pit-based MOC arrangement as a basis of design for business-as-usual application by National Gas.

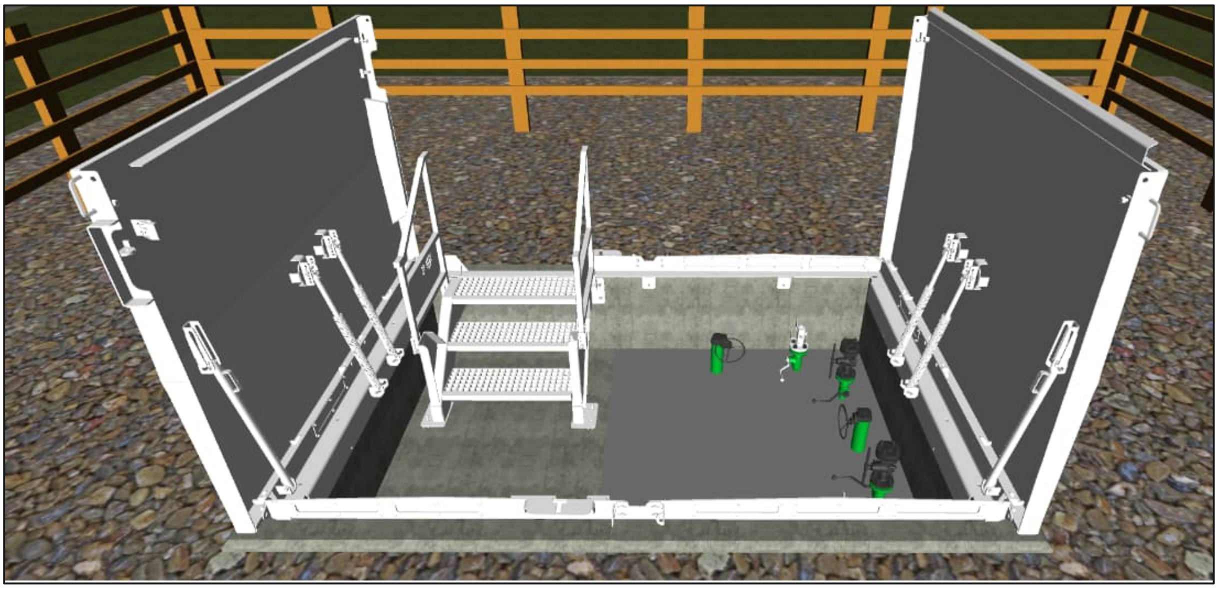

Figure 1: 3D Model of Proposed Standardised Minimum Connection

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1 Introduction

1.1 Project Background

Following consultation with biomethane industry experts, National Gas Transmission (NGT) are looking to offer a standardised minimum connection arrangement at greenfield locations with low visual impact by locating the network isolation valves or MOC valves in pits. This would alleviate the more time-consuming process of designing traditional and larger above ground installations (AGIs) with perimeter security fences, internal vehicle access and obtaining planning permission from local authorities and landowners.

The use of pits to house valves on National Gas AGIs has often led to operational and maintenance issues, such as pipe-pit wall transition corrosion, pit flooding, explosive atmospheres due to gas accumulation where ventilation is inadequate, and restricted access and egress. However, following consultation with National Gas' Chief Engineer, a decision support paper was submitted and approved allowing the development of a valve pit arrangement to align with requests from the biomethane industry and address historic issues. See paper NTS 23001 in Appendix A for more information.

Following this decision, conceptual designs for minimum offtake connections at Oulton Airfield and Manby projects were completed in 2024. These designs included a concept design for a standardised MOC valve arrangement in a pit, as shown in Figure 2.

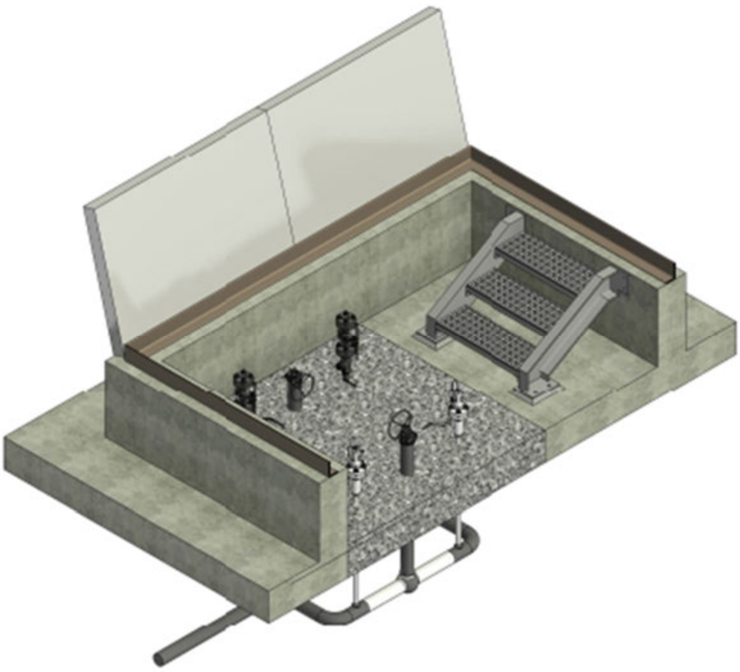

Figure 2: Isometric Section of Conceptual MOC valve in pit

National Gas have secured innovation funding to develop this concept into a fully engineered solution that can be proposed to customers once connection offers are accepted. It is anticipated that there will be up to five biomethane customers looking to progress their connection offers over the next 12 months.

1.2 Project Aims

This project aims to develop the conceptual design into a comprehensive detailed design which will have been scrutinised and accepted by key stakeholders in the National Gas business and subjected to Subject Matter Expert (SME) challenge and review and Formal Process Safety Assessments (FPSAs). The design will then be internally checked and approved and issued to National Gas for acceptance as a basis of design for business-as-usual application by National Gas.

The aim of this project is to standardise the design of the biomethane MOC pipework arrangement and develop a detailed design of a suitably sized valve pit, complete with secure access covers.

The design process will aim to resolve common design concerns and challenges such as:

- Pit construction materials
- Drainage
- Variable ground conditions
- Pipework corrosion around pit wall transitions
- Security
- Impact protection
- Accessibility and operability
- Hazardous areas and ventilation
- Minimising site construction
- Suitability for intended design life
- Planning requirements

1.3 Anticipated Benefits

Developing a standard design for small scale customer connections onto the National Transmission System (NTS) presents clear benefits throughout the lifecycle of a connection project, from initial enquiry to commissioning the connection.

1.3.1 Pre application Enquiry

NGT could advise customers of indicative costs, timescales and footprint requirements for a MOC as part of a pre-application screening process. Customers would not need to pay application fees for this indicative information.

1.3.2 Conceptual Design and Connection Offer

The scope of the conceptual design study (CDS) could be reduced to a review of the connection location alongside basic access and layout drawings. All other conceptual design information would be standard. This will allow a connection offer to be returned faster than the Uniform Network Code (UNC) stipulated time scales.

1.3.3 Detailed Design

Only site-specific design costs associated with the mechanical, cathodic protection (CP) and civil design of the pipework and pit would be incurred at this stage. Design reviews and T/PM/G/35 [1] approvals and appraisals can be made simpler, more time-efficient and more cost-effective as a result.

1.3.4 Materials and Construction

An inventory of standard valves, pipe and fittings can be held, thus reducing lead time.

Precast pits and covers could be procured in batch quantities to save cost and timescales for one-off orders. Construction costs would therefore be more certain.

More pre-fabrication opportunities would be available which could eliminate or reduce on-site fabrication time.

All in all, with around 50 initial enquiries for a small offtake connection to the NTS currently being dealt with by the customer connections team, the cost and time saving and benefits to both National Gas and the customer are significant.

1.4 Project Scope

This innovation design project covers the design of the isolation valve and bypass pipework arrangement for both 80mm NB and 100mm NB minimum exit connections and minimum entry connections including the potential for bi-directional flow, for customers that are both suppliers and consumers.

The scope of the design is limited to the compound defined by the post and rail fence, along with the underground pipework between the inlet and outlet isolation joints (IJs) with an adequate access chamber that ensures safe working access to the isolation valve arrangement, whilst limiting inherent concerns and above ground footprint. Although recent National Gas schemes trend towards the removal of operable below ground assets from the NTS where possible, this project aims to develop an exceptional below ground solution that mitigates any safety and operational risks associated with legacy pit configurations.

Access track arrangements outside the scope of this project, as they differ depending on the specific site location and various surrounding infrastructure found at greenfield locations. The elements of the arrangement that are within the scope of this project are shown by the red demarcation in Figure 3.

Hot tap connections are also out of scope of the project as this is considered ‘business as usual’. However, the materials associated with the mechanical design for the 80mm NB, and 100mm NB offtake connections are provided to allow early procurement of these components.

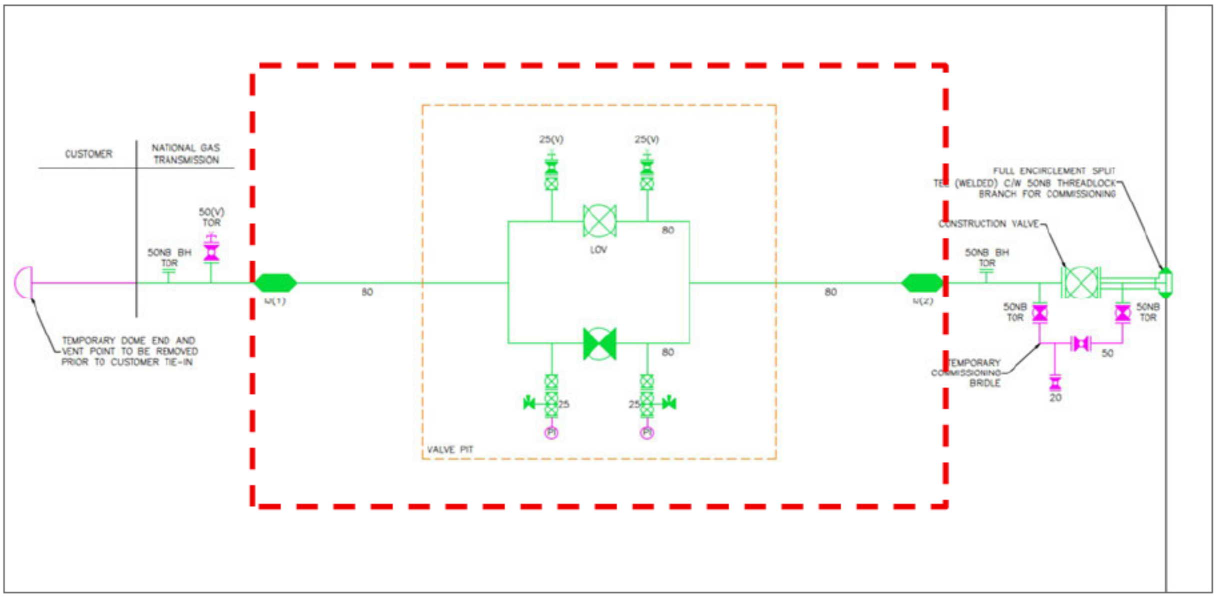

Figure 3: Typical minimum connection showing Scope of Works

The limitations on the use of this design, as described in section 3.8 will result in this MOC solution requiring an independent gas transporter to own and operate a section of pipeline between the MOC and the Customer facility. In accordance with IGEM/G/1 – Defining the end of the Network, an Emergency Control Valve (ECV) shall be placed at the end of the network, i.e. at the interface between the Independent Gas Transporter (IGT) and the Customer. Based on this there is no requirement to designate the valves in the pit as ECV's and no requirement for any 3rd party to be given access to these in an emergency.

There are additional considerations and risks associated with entry connections that are not a concern with exit connections, such as overpressure protection and gas quality specification. These risks are not within scope of this project but will be captured in the HAZID Report provided in appendix A and the obligations placed on the Customer are covered in the Technical Guidance Document developed as part of this project and provided in appendix B.

There are several prerequisites that are required upstream of the scope of this project including gas quality control (shut off for out of specification gas), pressure control (IGEM/TD/13 [3] compliant overpressure protection), these are also out of scope of the project. These prerequisites are also covered in the Technical Guidance Document provided in appendix B.

1.5 Document Objectives

This document aims to rationalise and record all notable factors that have led to the final design. Decisions made following meetings, adherence to industry standards, communications with third party suppliers, specialist engineering judgement, calculations, and more have been logged in this report to justify the design philosophy. The design journey shall be captured with a comprehensive level of detail. The presented final optimised solution for the MOC shall be submitted to National Gas for acceptance as a basis of design for business-as-usual application.

2 Design Management

2.1 Design Plan

Key steps:

- Design Development
- Mechanical Design
- Civil Design
- Safety Engineering
- Internal Design Approvals
- Future development of T/PM/G/19 [4] model designs

2.2 Design Review, Progress and Coordination Meetings

- Weekly coordination meetings held throughout the project
- Kick off and Conceptual Design Review – 29th April 2025
- Security team requirements review – 4th June 2025
- Risk Workshop session 1 – 10th June
- Risk workshop session 2 – 4th July 2025
- Design Review session – 21st August 2025
- Conclusion of FPSA studies – 3rd December 2025
- Internal Design Approvals – January 2026
- Project close out – 31st March 2026

3 Design Requirements

3.1 Legislation

The following legislation is applicable to the project

- Construction (Design and Management) (CDM) Regulations 2015 [5]
- Health and Safety at Work etc. Act 1974 [6]
- Pressure Systems Safety Regulations 2000 [7]
- Pipelines Safety Regulations (PSR) 1996 [8]
- Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 [9]
- Gas Safety Management Regulations (GS(M)R) 1996 [10]
- Gas Safety (Installation and Use) Regulations (GS(I&U)R) 1998 [11]

3.2 Specifications and standards

The main codes of practice and specifications to be applied to the mechanical design are:

- IGEM/TD/1 Edition 6 [2] - Steel Pipelines for High Pressure Gas Transmission
- IGEM/TD/12 Edition 3 [12] - Pipework Stress Analysis for Gas Industry Plant.
- IGEM/SR/25 Edition 2 [13] - Hazardous Area Classification of Natural Gas Installations
- T/SP/TR/18 [14] - Engineering of Pipelines and Installations Operating at Above 7 Barg
- T/SP/P/10 [15] - General Pipelining Designed to Operate at Pressures Greater Than 7 Barg
- T/SP/PW/11 [16] - Pipework Systems Operating at Pressures Exceeding 7 Bar

The main codes of practice and specifications to be used in civil design are:

- T/SP/CE/1 [17] - National Gas Transmission Specification for the design, construction and testing of civil and structural works – General.
- T/SP/CE/2 [18] - National Gas Transmission Specification for the design, geotechnical, ground works and foundations.
- T/SP/SHR/1 [19] - National Gas Transmission Specification for the design, stairs, steps, fixed ladders, platforms and guard-rails.
- EN1991-1-1 - Eurocode 1: Actions on Structures. [20]
- EN1992-1-1 - Eurocode 2: Design of concrete structures. [21]
- EN1993-1-1 - Eurocode 3: Design of steel structures. [22]
- BS 5359-1:2011 - Code of Practice for stairs for limited access. [23]

3.3 Design Parameters

The design parameters which will be used for the mechanical design are shown in Table 1.

Table 1: Design Parameters

Parameter	Value	Remarks
Design Pressure (DP)	94 barg	Design pressure equal to MOP
Maximum Operating Pressure (MOP)	94 barg	Based on the highest pipeline MOP observed on the NTS
Safe Operating Limit (SOL)	99.64 barg	Typically, 1.06 x MOP for >70barg systems as per T/PM/PS/3
Design Factor*	0.72	At the stated MOP, the designs are only suitable for use in R-type areas.
Minimum operating pressure	38 barg	Used for the purpose of velocity calculations
Maximum Flowrate (80mm NB MOC)	14,800 scmh	As determined in section 5.3.2
Maximum Flowrate (100mm NB MOC)	25,100 scmh	As determined in section 5.3.2
Design Temperatures	-20 to + 60 °C	to align with T/SP/PW/11 Part 1
Normal operating temperature	5 °C	Used for the purpose of velocity calculations
Gas Quality	100% natural gas	In compliance with GS(M)R schedule 3 part 1
Minimum Design Life	20 years	Biomethane plants are typically expected to operate up to 15 – 20 years.

*If the installation is located within an S-type area classification, thus limiting the design factor to 0.3, the design pressure of the system and feeder the MOC is connected to will be limited to 75 barg for an 80mm NB installation.

The standard design for the 100mm NB pipework arrangement with the specified wall thickness of 6.0mm is not suitable for an S-type area classification. A bespoke pipework design with thicker wall pipe and 25% reduced capacity will be required in this instance.

3.4 Design Principles

The MOC in a pit concept arrangement has been developed as part of two recent MOC connection application conceptual design studies. The standardised concept will be based on these designs.

A risk workshop has been carried out as part of the development of this project, risk worksheet can be found in appendix A, with key stakeholders across the National Gas business establishing additional design principles and limitations across which the pit design will be viable.

The following key parameters have been identified:

- Limited to 80mm NB and 100mm NB pipework
- Suitable for entry and exit connections
- Match maximum design pressures on the NTS
- Minimise the depth of the pit
- Valve arrangement to include full bypass valve pipework

The detailed design of the pit will be standardised to suit both pipework sizes and arrangements.

3.5 Design Assumptions

A design Assumptions and Decisions Register was created and has been frequently updated to reflect the design developments and discussions with NGT stakeholders. The current version of the register can be found in Appendix B.

3.6 Pit Considerations

The following key considerations have been identified concerning the introduction of a pit in the design:

- Corrosion due to water ingress
- Risk to public / interference
- Risk of third party damage
- Hazardous area classification
- Ergonomics
- Environmental impact
- Associated costs

National Gas' specification for Engineering of Pipelines and Installations, T/SP/TR/18 [14] also outlines some requirements for valve pits where *'other alternatives are not practicable'*. Engineering Justification Papers have also been developed by National Gas to support the removal of pits on site in the RIIO GT3 price control period. Key points from these papers are presented in Table 2.

Table 2: RIIO GT3 Pit Removal Reasoning

No.	Narrative	Source Engineering Justification Paper (EJP)
1	[redacted]	[redacted]
2	[redacted]	[redacted]
3	[redacted]	[redacted]
4	[redacted]   	[redacted]
5	[redacted]	[redacted]

No.	Narrative	Source Engineering Justification Paper (EJP)
		
6	[redacted] - [redacted] - [redacted]	[redacted]
7	[redacted]	[redacted]

No.	Narrative	Source Engineering Justification Paper (EJP)
		
8	[redacted]	[redacted]

3.7 Security Access Requirements

The security design for the pit installation is inconspicuous but robust, centred around SR3-rated access covers to LPS 1175 [24]. These are equipped with shrouded padlock points and brackets for alarm contacts, meeting the minimum requirements from the National Gas Security Team. This negates the need for high-security fencing, allowing for a simple post and rail boundary to serve only as demarcation and hazardous area separation. Full details can be found in Section 7.3.1.

3.8 Prerequisites for Application of Standard Connection Design

There are prerequisite conditions and obligations on the connecting customer that must be in place or contractually agreed to before the application of this standard design can be offered. The latest decision tree flowchart available in Appendix B. The items listed below are specific to the acceptability of the standard MOC in pit design or alternative above ground solution for a given application:

- The proposed location of the MOC shall be within 150m of the point of connection to the NTS. Consideration should be given to minimising the length of non-piggable pipeline created by the customer connection.
- The proposed location is not within a potential flood zone which is cause for concern. The pit is designed to deal well with occasional flooding and drainage of excess water; thus, a flood zone limitation is not advised. An appropriate flood zone will depend on the regularity of access, food zones throughout the nearest vehicular access route on a site by site basis, and true local flood behaviour following discussions with the landowner.
- Customer flow requirements can be accommodated within a connection size of 100mm NB or less.
- The customer development boundary is more than 30m from the proposed point of connection and a connecting IGT pipeline is required. In instances where the customer site is located very close to the connection location on the respective Feeder then an AGI with a secure compound forming part of the customer development site and planning red line boundary would be offered.
- Suitable location with nearby access track or road with suitable layby. Turning arrangements must be included if necessary.
- Security assessment to ensure the site location is in line with existing rural sites which have already been assessed. No additional risks that would elicit the need for security fencing are anticipated to be present in the design.
- Suitable ground conditions including water table level greater that 1m below ground level, bearing pressure, and drainage (refer to section 7.1).

All the factors listed in the decision tree flowchart must be appropriately considered and documented in a connection offer and site specific conceptual design study with suitable oversight and auditing from National Gas. This is likely to include National Gas involvement in the customer plant design review processes.

The standard design package shall refer to these prerequisites to ensure any proposed connection site is compliant prior to an application being submitted or an offering of the standard design solution.

4 Functional Requirements

The proposed connection design should provide the following functionality based on typical National Gas minimum connections and built to suit National Gas typical operating procedures:

4.1 Connection to the NTS

The purpose of the minimum connection facility is to provide a point of connection for a customer to flow gas into the NTS (entry connection) or take gas from the NTS (exit connection). This design is focused on connections to buried feeder pipelines, where no outages are anticipated to be scheduled for the works. Given this requirement, the feeder connection is made using under-pressure connection techniques via a hot tap tee and construction valve attached to a section of buried pipeline.

The detailed requirements of the under-pressure connection arrangement are “business as usual” and are therefore not within the agreed scope of the standardised design.

4.2 Locally Operated Valve

The Locally Operated Valve (LOV) provides a means for National Gas to isolate the NTS from the customer pipework. The valve is not intended to be used in routine operations, but it could be used to fulfil legal and safe operational requirements as set out by NGT and the HSE. The valve will be fitted with a suitable gearbox and handwheel arrangement. A local position indicator showing ‘open’ or ‘closed’ will also be required for the LOV.

All valve operations are to be carried out by National Gas operatives only although the customer may request that the LOV be closed.

The valve shall not be defined as an ECV as documented in section 1.4.

4.3 Bypass Arrangement

The LOV will need to be closed during its occasional valve functional check and maintenance works. To ensure that the customer’s supply is not cut off during the works, a bypass arrangement will be required. The bypass must be full bore to remove any restrictions on the customer’s flow and typically includes a manually operated ball valve that is opened before the LOV has closed as part of the maintenance routine. In normal operation this bypass valve will be closed and locked.

4.4 Vent Connections

As part of the bypass arrangement there should be a means to purge and commission up to the LOV and equalise pressure across the LOV. This can be done by making use of the vent valves either side of the LOV along with temporary vent stacks and hoses.

4.5 Pressure Gauges

In accordance with the critical valve functional check work procedure T/PR/MAINT/5031 [25], gauge connection points will be provided to enable the temporary installation of two dial indicator pressure gauges, one either side of the LOV. The connections will include a suitable block and bleed connection arrangement.

4.6 Insulation Joints

The NGT transmission pipeline has a corrosion protection system supported by an impressed current cathodic protection (CP) system. This system is most efficient if inadvertent earth connections are avoided as they cause a current drain point. Insulation joints have therefore been included in the design to separate the existing Feeder pipework from the MOC and the MOC from the customer pipework.

The minimum connection pipework can be cathodically protected via a bond over the insulation joint provided the adequacy of the upstream pipeline CP system is evaluated. Refer to section 8 for further details on the CP design.

4.7 Customer Tie-In Point

The installed minimum connection facility shall terminate below ground outside of the National Gas site boundary with a suitably isolated dome end arrangement, vent and vapour block bag connection to allow a welded connection to the customer's pipeline or asset. This is to enable the customer to carry out connection works without requiring access to National Gas operational land.

4.8 Minimum Connection Operational Considerations

In the normal course of the minimum connection's life, all valves forming part of the minimum connection pipework arrangement will not require operation other than for maintenance purposes. The frequency of maintenance is once per year and may be completed within one day.

4.8.1 Telemetry

No form of remote monitoring or control is required for the minimum connection arrangement hence no instrumentation or telemetry systems have been associated with the standard connection.

Note: The telemetry from the connected customer will typically be supplied using a National Gas 4G telemetry repeat system installed on the customer site which will be relayed to a nearby National Gas AGI with telemetry system. Suitable 4G signal will therefore be prerequisite requirement for location of the standard connection design.

4.9 Minimum Connection Maintenance Considerations

4.9.1 Valve Maintenance

A full bore bypass is required to facilitate valve functional checks and maintenance activities without reliance on customer outages.

The configuration, physical position and spacing for the valves has been considered when designing the pit to ensure the required maintenance can be carried out safely and in accordance with the following NGT procedures.

- T/PM/MAINT/5 Part 1 – Management Procedure for Maintenance of Pipelines Operating Above 7 Barg – Part 1 – Control Of Maintenance Activities

- T/PR/MAINT/5031 [25] - Work Procedure for the Functional Check of Critical Valves With Inlet Pressures Above 7 Bar (Local Operation)
- T/PR/MAINT/5032 - Work Procedure for the Functional Check of Non-Critical Valves With Inlet Pressures Above 7 Bar (Local Operation)

As prescribed in T/PM/MAINT/5 the primary isolation valve at a pipeline spur is a Critical Valve. Both the main valve and bypass valve are therefore Critical Valves. The frequency of the functional check for critical valves is once every 12 months.

The maintenance requirements and method are fully set out in Section 6.1 to 6.5 of T/PR/MAINT/5031 [25]. In summary, maintenance procedures are to '*Operate the valve through 90^o using manual handwheel/wrench, monitoring gauges throughout. Body vents, if fitted, should be piped to a safe location (ideal vent and min. 3 metres above ground), i.e. venting and purging operations should only be carried out when all possible ignition sources within the site have been identified and eliminated. Open body vent when valve is in closed position, depressurise body to atmosphere and confirm satisfactory seal. Close body vent.'*

National Gas specification T/PR/MAINT/5031 [25] describes a partial valve movement option where a full closure would affect system flow rates. For these small-scale customer connections, the valve maintenance requirements necessitate full operation hence the inclusion of the full bore bypass.

Pressure gauge connection points are provided either side of the valve, along with vent / pressure equalisation valve connection points.

4.9.2 Leakage Surveys

In accordance with National Gas specification T/PM/MAINT/5'*a leakage survey should be undertaken annually on all unfilled block valve chambers, which are directly accessible to the public. This survey should include measurement of gas concentration at the edges of the valve chamber and at any gaps or cracks in the valve chamber cover. It would not normally be necessary to remove the valve chamber cover to carry out this survey. Remedial action should be taken if there is any evidence of leakage inside the valve chamber.'* This should form part of the annual maintenance routine for MOC connections in pits.

4.9.3 Pit Maintenance Considerations

Visual inspections on all pipework above the pit invert level should be conducted with the similar logical procedures to typical AGIs as stated in T/SP/CM/4 [26]. All pipework protrusions will be within a closed pit and therefore will be less susceptible to the usual degradation associated with wind and water lines on stems which are typically far more exposed.

However, the enclosed space can be more susceptible to algae build up due to potential still air, and such build ups should be removed regularly to maintain the effectiveness of the corrosion protection systems and longevity of the assets.

Frequency of T/SP/CM/4 [26] inspections and a proactive approach to treating early signs of pipe and pit cover corrosion is therefore recommended.

As evidenced in section 7, the precast pit civil design cannot provide the desired separation distances for carrying out shot blasting and recoating activities, however, shot blasting is not required as part of a FBE coating repair in section B.2.2 of T/SP/CM/4 [26], a common misconception in safety studies of late. As FBE coated equipment will be provided in the pit, the surface shall be abraded and MCL applied.

As a last resort and if the increased frequency of inspections and interventions has not prevented the onset of severe corrosion to pipework then this will require a re-lifing procedure with the pre-cast chamber unearthed and lifted, affected pipework fully exposed and shot blasted, new coating applied and pit structure reinstalled. Lifting eyes are to be left in place upon installation of the unit to aid lifting if such intervention is required.

Safe access procedures are available in section 10.6 for any required maintenance activities.

4.10 Construction, Commissioning and Decommissioning Considerations

Construction considerations must be examined on a site by site basis in most cases. Critically, the access route and lifting arrangements for the delivery and removal of the precast pit structure and combined cover assembly must be deemed suitable by the contractor.

Vent valves are supplied either side of the isolation valve to facilitate venting and purging during commissioning and decommissioning activities.

It is assumed that National Gas assets will not be utilised for commissioning of the customer site asset. For example, the customer will not carry out hydrostatic testing against the National Gas owned valve. It will be the responsibility of the customer to provide suitable isolation to facilitate their testing and commissioning procedures.

As per the relifing procedure described for pit maintenance in section 4.9.3, at the time of decommissioning the MOC the pit and associated assets can be lifted out following a shallow excavation.

5 Mechanical Design

5.1 General

The pipework arrangement for this standardised design has been developed with consideration of the functional requirements described in Section 4 along with any constraints associated with pits and pit covers as described in Section 7.

As shown in Figure 4, a series of arrangement options has been developed for evaluation against these constraints. The aim was to have a standard pit size for both 80mm and 100mm diameter pipework hence the following evaluation was carried out on the 100mm pipe options.

Based on the evaluation below Option 4 was selected to be taken forward, Option 5 was deemed to be the next best option.

5.1.1 Option 1

This concept design option provided a central step-down access into the middle of the valve arrangement. The concept was eliminated due to the need for pit covers to be hinged along the short sides of the pit.

5.1.2 Option 2

To address the need for pit covers to be hinged along the short sides of the pit the step assembly was placed on the long side and still landing on the same size concrete base. Valve arrangement remains the same as Option A but access to the central area is restricted.

5.1.3 Option 3

With the same step arrangement, this option changed the pipe orientation and some valve positions to give a clearer access from the landing area into the valve area.

5.1.4 Option 4

This option involves a pipework arrangement which provides greater clear access into the valve area. This option provides the largest clear area for operation staff to access and operate all valves within the pit.

5.1.5 Option 5

This option considers placing the steps centrally along the long side of the pit with the valves running either side of the central landing area. Access to two valves is restricted by the steps.

5.1.6 Option 6

The valve arrangement in this option is symmetrical with the inlet and outlet pipework tees being located under the central concrete base. This pipework arrangement is less preferable compared to option 5.

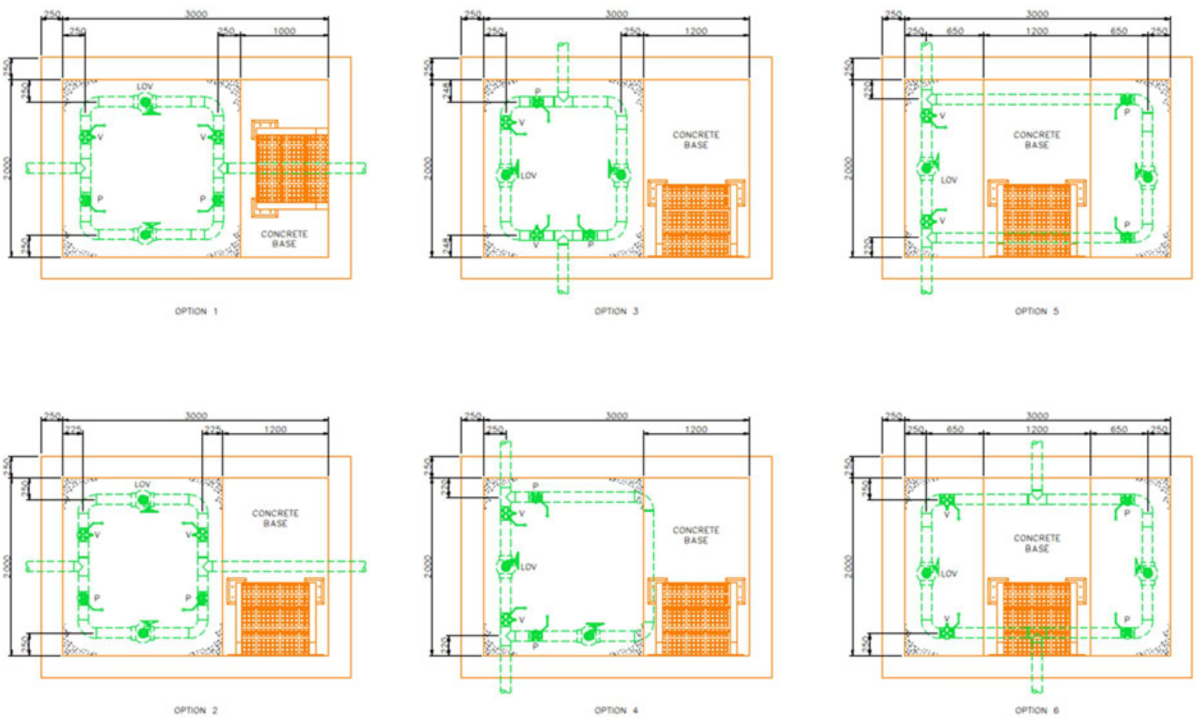

Figure 4: Conceptual bypass configurations – 100NB

5.2 Materials

All materials, fittings and equipment that will form a permanent and/or temporary part of the installation have been designed to meet the defined process conditions and to withstand the environmental conditions in accordance with all relevant standards and specifications. This includes the requirement for continuous service without significant corrosion, erosion or other deterioration.

All the materials required for the permanent mechanical works are listed in the Material Take-Off (MTO) provided in Appendix C. It is noted that quantities do not include a provision for pressure testing fittings. Materials shall be procured in accordance with the *European Community (EC) Utilities Directive* and will be supplied complete with certification and evidence a of *ISO 9000* quality review.

5.2.1 Valves

All main line valves will be ball valves in accordance with National Gas specification T/SP/V/6 [27] and all instrumentation valves will be in accordance with National Gas specification T/SP/V/8 [28].

The LOV and bypass ball valves shall be double block and bleed type and shall include a separate vent and drain connection. Sealant injection lines are not available on 80mm valves but will be included on 100mm NB valves.

The vent valve size for purging and ventilation operations has been selected as 25 mm NB in accordance with Table 2 of IGEM/SR/22. It is noted that National Gas Specification T/PM/TR/30 recommends a purge vent size of 40mm NB but this size has not been taken forward due to the small volumes of pipework requiring venting at the MOC.

5.2.2 Valve Actuation

The 80mm and 100mm NB ball valves will not require any powered actuation. They will be fitted with a gearbox and manual handwheel. Valves shall include the facility to padlock them in both open and closed positions.

5.2.3 Fittings

Factory steel bends with a bend radius of 1.5D shall be used in accordance with National Gas specification T/SP/B/12 [29].

Factory made equal and reducing tees shall be used in accordance with National Gas specification T/SP/B/12 [29].

Factory made (forged) weldolets shall be used in accordance with National Gas specification T/SP/F/1 [30].

Ring Type Joint (RTJ) flanges shall be used in accordance with National Gas specification T/SP/F/1 [30].

5.2.4 Pressure gauge connections

In accordance with T/SP/INP/3, pressure gauges shall have a ½ inch parallel thread connection in accordance with BS 1780. Therefore, the double block and bleed valve shall have British Standard Pipe Parallel (BSPP) connections for the pressure gauges.

5.2.5 Insulation Joints

Insulation Joints will be in accordance with National Gas specification T/SP/E/56 [31].

5.2.6 New Pipework

All pipes will be in accordance with National Gas specifications T/SP/PIP/1 [32] with appropriate wall thicknesses from T/SP/DAT/6 [33].

Table 3: Proposed New Pipework

Nominal Diameter (mm)	80mm NB	100mm NB
Specification	T/SP/DAT/6 [33] T/SP/PIP/1 [32]	T/SP/DAT/6 [33] T/SP/PIP/1 [32]
Material Grade	L245NE	L245NE
Pipe Type	Seamless	Seamless
Outside Diameter (mm)	88.9	114.3
Nominal Wall Thickness (mm)	5.5	6.0
External Coating	T/SP/CW/6	T/SP/CW/6

Internal Coating	T/SP/CM/1 [17]	T/SP/CM/1 [17]

5.3 Design Calculations

5.3.1 Design Factor

The design factor for a section of pipe site can be determined in accordance with IGEM/TD/1 [2] as the ratio of yield strength to hoop stress. This can be determined from the following expression:

$$f = \frac{PD}{20 t_{min} s}$$

Where:

- $D = Outer\ Diameter\ of\ Pipe$
- $t_{min} = Wall\ Thickness\ less\ under\ thickness\ tolerance$
- $P = Design\ Pressure$
- $s = SMYS\ (Specified\ Minimum\ Yield\ Strength)$

Table 4: Design Factor Calculations

Nominal pipe diameter (mm)	80mm NB	100mm NB
Outer Diameter (mm)	88.9	114.3
Nominal Wall Thickness WT (mm)	5.5	6.0
Wall Thickness Under-tolerance	-12.5%	-12.5%
Minimum Wall Thickness (mm)	4.81	5.25
Design Pressure (barg)	94	94
Material SMYS (N/mm^2)	245	245
Calculated Design Factor	**0.354**	**0.418**
Maximum Allowable Design Factor (IGEM/TD/1)	0.72	0.72

The MOC pipework has been selected to be suitable for the highest design pressure of any operational feeder on the NTS of 94 barg but only when placed within a rural setting which R-type area classification.

If the installation is located within an S-type area classification, thus limiting the design factor to 0.3, the design pressure of the system and feeder the MOC is connected to will be limited to 75 barg for an 80mm NB installation.

The standard design for the 100mm NB pipework arrangement with the specified wall thickness of 6.0mm is not suitable for an S-type area classification. A bespoke pipework design with thicker wall pipe and 25% reduced capacity will be required in this instance.

5.3.2 Gas Velocity

As the gas is being treated as unfiltered, the maximum flow velocity has been limited to 20 m/s in accordance with section 6.2 of IGEM/TD/1 [2]. A suitably sized connection will be selected for the customer's flowrates at a minimum operating pressure of 38 barg and 5ºC gas temperature. The maximum flowrate through each size of MOC pipework is shown in Table 5 below. Supporting velocity calculations can be found in Appendix D.

Table 5: Maximum Flowrates

Pipe Size	SCMH (@38 Barg)
80 mm	14,460
100 mm	25,100

5.3.3 Test Pressure

The on-site hydrotest requirements shall be determined in accordance with IGEM/TD/1 [2] as part of the site specific detailed design and should consider the MOP feeder operating pressure, predicted operating pressure cycles and test limits.

In accordance with 8.2.2.1 of IGEM/TD/1 [2] a pipeline designed for operation at a design factor exceeding 0.3 shall be tested to the requirements of table 11. As shown in the calculations in appendix D this would result in a test pressure in excess of the allowable test pressures of class 600 ball valves. To validate a lower test pressure of 1.5 x MOP the site-specific detailed design will need to demonstrate that the pipeline will not be significantly line packed, with daily variations in hoop stress not exceeding 35 N mm^{-2}. If this cannot be demonstrated, then a detailed fatigue assessment of the expected pressure cycling should be carried out to show that the required design life is achieved.

5.4 Pipework Stress Analysis

Stress analysis cannot produce meaningful results for the standardised design without situational context. This will need to be completed as part of a site-specific design once the pipework arrangement and existing feeder size is known. The stress analysis completed as part of this site specific detailed design shall be carried out in accordance with IGEM/TD/12 [12] and will be subject to a site-specific T/PM/G/35 [1] approval and appraisal.

As part of the site specific design and depending on the selection of a grouted or welded split tee, additional analysis will be required on these tees to demonstrate there are no stress exceptions in accordance with IGEM/TD/12 [12].

5.5 Fabrication

The design intent is for the MOC pipework in Figure 5 and customer connection arrangement in Figure 6 to be fabricated and tested off-site in workshop conditions. The two fabrications can then be delivered to site and connected to the under-pressure connection arrangement via site run pipework.

All welded joints associated with these fabrications shall be carried out in accordance with T/SP/P/8 [35]. Remaining on site welding shall be carried out in accordance with T/SP/P/2 [36] All welds shall be inspected in accordance with T/SP/NDT/2 [37].

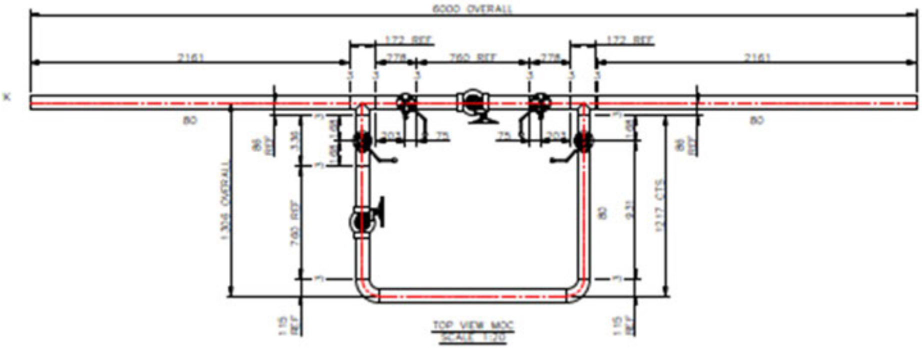

Figure 5: MOC Arrangement Fabrication

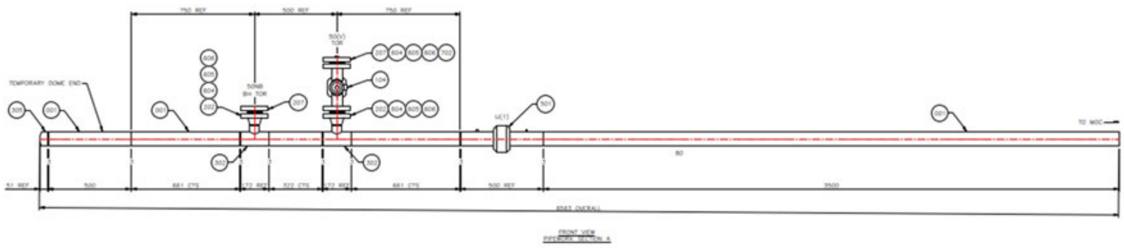

Figure 6: Tie-in Arrangement Fabrication

6 Hazardous Area Classification

6.1 Hazardous Area Classification Requirements

Hazardous area classification allows National Gas to assess and control risks associated with explosive atmospheres, such as provision of ventilation, reduction of leak sources, and control of ignition sources.

Hazardous area classification is a legislative requirement under the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 [9] and is carried out in accordance with IGEM/SR/25 Edition 2 [13] and T/SP/HAZ/10 [38]. It is required to eliminate or reduce risk from dangerous substances as far as is reasonably practicable in accordance with DSEAR regulations [9].

When considering the introduction of a pit on a National Gas installation, it is necessary to determine the level of ventilation and classify the zone accordingly. Introducing an enclosed space with potential leak sources can increase the likelihood of an explosive atmosphere being present in that space.

6.2 Hazardous Area Zone Classifications

The following hazardous area zone classifications are detailed in IGEM/SR/25 Edition 2 [13].

Table 6: Hazardous Area Zone Classifications

Zone 0	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is present continuously, or for long periods or frequently.
Zone 1	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is likely to occur in normal operation occasionally.
Zone 2	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will exist for a short period only.
Zone 0 NE	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is present continuously, or for long periods or frequently, but would be of negligible extent.
Zone 1 NE	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is likely to occur in normal operation occasionally but would be of negligible extent.
Zone 2 NE	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is not likely to occur in normal operation, but if it does occur, will exist for a short period only and would be of negligible extent.
Safe Area	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or dust is never present

6.3 Grades of Release

The following grades of release are defined in IGEM/SR/25 Edition 2 [13].

Table 7: Grades of Release

Grade	Definition	Examples
Secondary	A release which is 'not expected to occur in normal operation and, if it does occur, is only likely to do so infrequently and for short periods.	• Flange leakage, screwed connections and valve glands • Pressure relief valves vents when they are operating
Primary	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is likely to occur in normal operation occasionally but would be of negligible extent.	• Process vents • Valve seat of relief valves when not operating • Frequently operating purge points.
Continuous	An area in which an explosive atmosphere consisting of a mixture with air of gas, vapour or mist is not likely to occur in normal operation, but if it does occur, will exist for a short period only and would be of negligible extent.	• Some types of analysers • Some actuators • Some instrument vent pipes

The proposed new pit design is not expected to have any primary or continuous grades of release.

6.4 Automatic & Manual

Automatic releases can be present at any given time even if not likely to be present (e.g. zone 2). Manual releases are purposely controlled releases at times chosen by the operator, such as venting down a section of pipework by manually operating a valve, often connected to a temporary vent stack.

For the purposes of this report, automatic releases shall be assessed as manually controlled releases would be undertaken under a non-routine operation (NRO) with an appropriate temporary venting arrangement that would not cause gas release in the pit.

6.5 Flange Leakage, Screwed Connections & Valve Glands

There are several secondary release sources that will be in the proposed pit design including flanges and valves. Hazardous area zone assessment from anticipated flange leakage, screwed connections and valve glands (nominal hole size 0.25mm^2) has been carried out in accordance with the zoning distances shown in Figure 7, as given in IGEM/SR/25 Edition 2 [13].

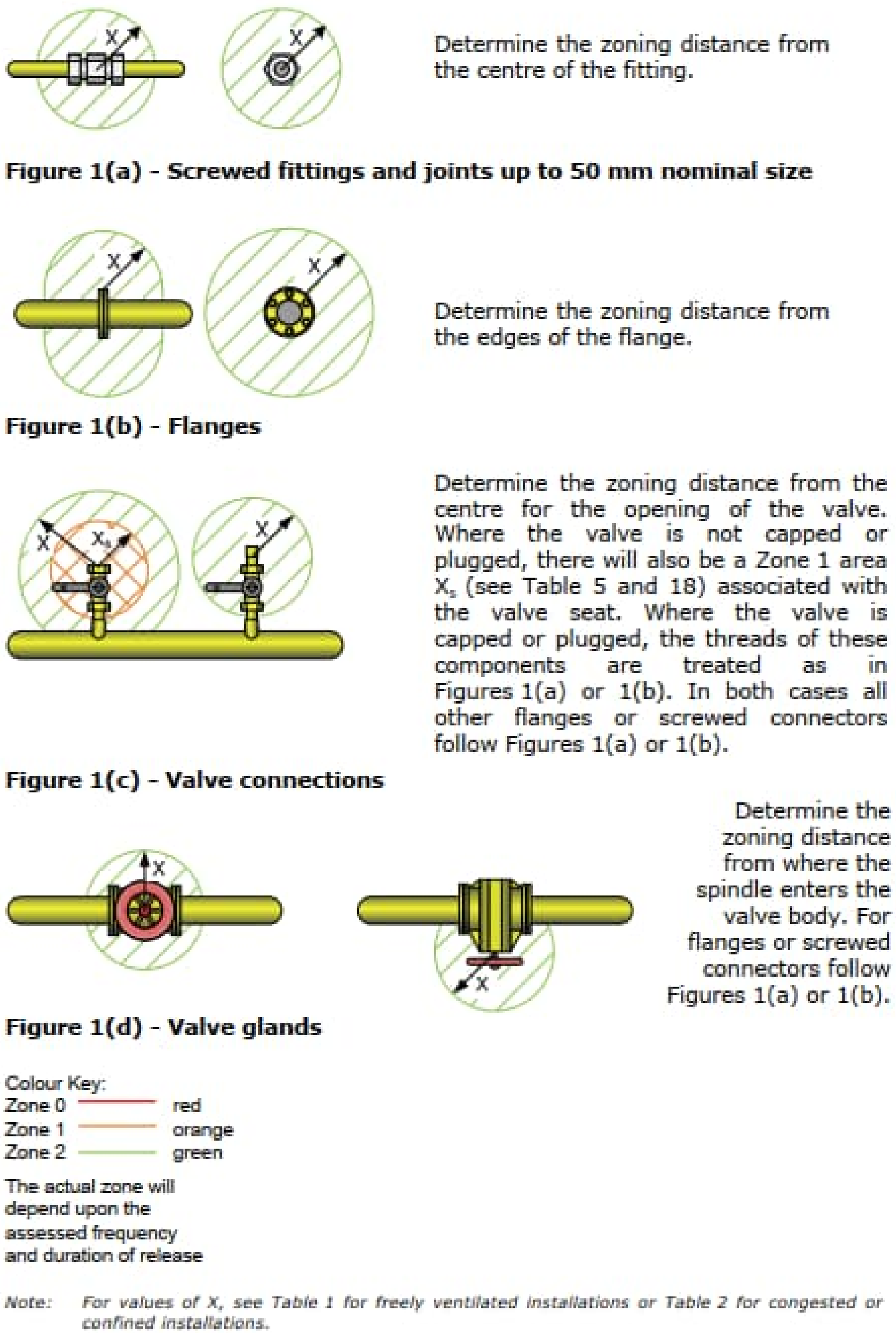

Figure 7: IGEM/SR/25 Edition 2 [13] Figure 1

6.6 Ventilation

IGEM/SR/25 Edition 2 [13] provides a methodology to determine the level of ventilation for various installation types. Once the level of ventilation has been established, the classification and extent of the hazardous area in the pit can be determined.

It is noted that most of the calculation methods of naturally ventilated and enclosed spaces are outlined in IGEM/SR/25 [13] and assume some high and low level airflow to encourage buoyancy effects.

Due to the shallow nature of the standard pit design, it is not practical to have high- and low-level ventilation with any meaningful height separation. Therefore methods provided in IGEM/SR/25 [13] section 5.5.1 cannot be directly applied, however the general principles have been applied in the following sections of this report.

The levels of ventilation defined in IGEM/SR/25 [13] are reproduced in Table 8.

Table 8: Ventilation Definitions

Ventilation Type	Definition
Natural Ventilation	Ventilation through an enclosed space where the flow of air is motivated by wind and/or buoyancy.
Artificial Ventilation	Ventilation through an enclosed space where the flow of air is forced or induced by mechanical means.
More than Adequate Ventilation	Any means of ventilation that is sufficient to ensure that a gas concentration in excess of 10% LFL is unlikely outside the classified zone(s).
Adequate Ventilation	Any means of ventilation that is sufficient to ensure that a gas concentration in excess of 25% LFL is unlikely outside of the classified zone(s).
Inadequate Ventilation	Any lesser level of ventilation than that required to achieve the objective of “adequate ventilation”.
Poor Ventilation	Levels lower than “inadequate ventilation”.

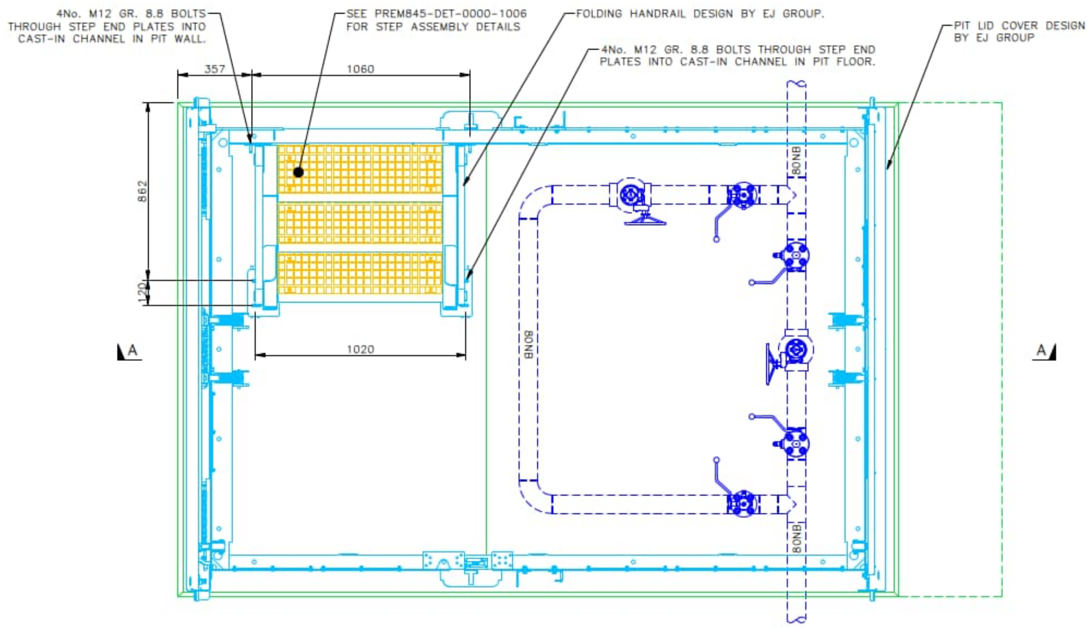

Figure 8: Proposed Pit Design Plan View – 80NB

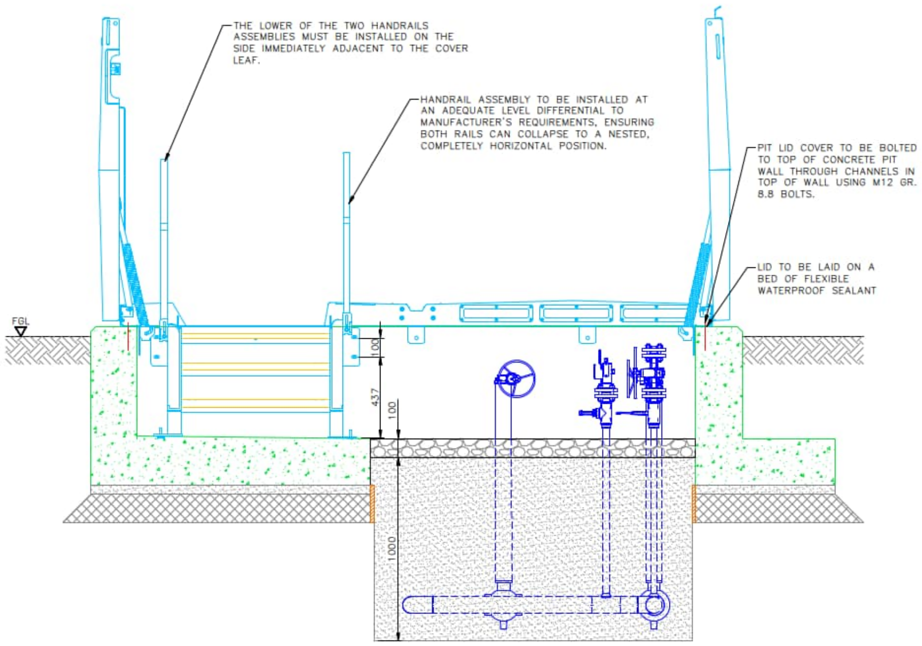

Figure 9: Proposed Pit Design Elevation View – 80NB

6.7 Covered Pit Ventilation

As the pit will typically have a closed security cover, the pit can be considered a covered pit.

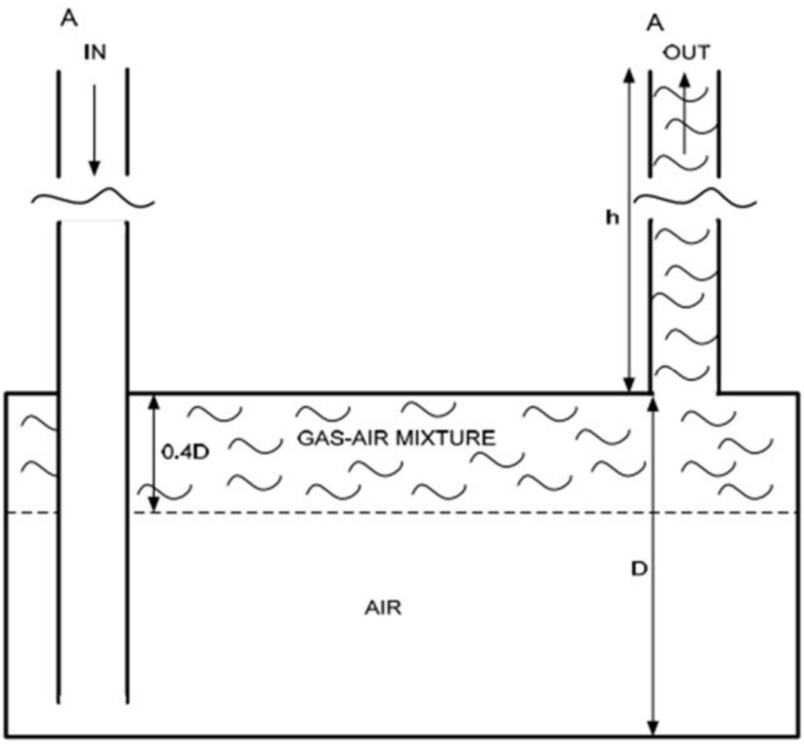

Figure 10: A Typical System of Buoyancy Driven Ventilation from IGEM/SR/25 [13]

6.7.1 Adequate Ventilation Test

IGEM/SR/25 Edition 2 [13] clause 5.5.1.1 states that for a pit with a vent system comprising of two vent pipes (Figure 10) and a ratio - maximum pit dimension / minimum pit dimension ≤ 3, the following criteria for adequate ventilation applies:

1. Vent pipes start at both high and low levels within the pit.
2. The vent pipe starting at high level within the pit terminates at least 1m above the other pipe.
3. The total cross-sectional area of the two pipes is not less than A_s (defined below).
4. The difference in cross sectional area between the two pipes is less than 10%.

$$A_s = 1360\, G\, \rho^{-1}(\, h + 0.4\, D)^{-0.5}$$

G = mass flowrate (kg s^{-1})

ρ = gas density (kg m^{-3}) (st)

h = total length of the tallest ventilator pipe (m)

D = vertical dimension of the pit (m)

Due to the shallow nature of the proposed pit (see Figure 8 and Figure 9), the maximum pit dimension (assumed length 3000mm) divided by the minimum pit dimension (assumed to be depth 600mm) is 5 (>3), therefore the adequate ventilation test is not applicable. The pit also does not have high and low level ventilators due to the geometry constraints.

Note: It can also be demonstrated that if the new arrangement were to be considered a large, covered duct (clause 5.5.1.2) rather than covered pit, adequate ventilation still cannot be achieved, therefore the same poor ventilation test applies.

6.7.2 Poor Ventilation Test

IGEM/SR/25 Edition 2 [13] clause 5.5.1.1 goes on to state if there is not "adequate ventilation" then there is inadequate ventilation or poor ventilation.

Ventilation is considered poor when:

$$A_S < 0.02\ A_F$$

Where:

A_S = total free cross sectional area of all ventilation openings

A_F = area of the floor of the enclosed space

For the pit design in question:

$$A_S < 0.02 \times 6.0\ m^2$$

$$A_S < 0.120 m^2$$

If the total free cross-sectional area of all the ventilation is greater than shown above, the ventilation is considered inadequate but not poor.

Since the grade of release in the pit is secondary, if the ventilation is inadequate but not poor, the entire pit shall be classified Zone 1 assuming the annual frequency of inspection and/or gas detection methods are deemed adequate in accordance with IGEM/SR/25 Appendix 7.

If the ventilation is deemed poor, the entire space shall be classified Zone 0.

6.7.3 Closed Pit Classification

The pit does not meet the adequate ventilation test as stated above. The design of the pit cover does however include for 10 separate vent apertures with fine insect mesh set into the frame of the pit cover. This will provide a free vent area greater than $0.12m^2$ as shown below.

Single vent CSA = $0.0189\ m^2$

Mesh transparency = 0.64 %

Single vent free area = $0.0121\ m^2$

Number of vents = 10

Total free vent area = $0.121\ m^2$

Therefore, the pit could be classified as a Zone 1 with inadequate ventilation. However, it is not clear in IGEM/SR/25 Edition 2 [13] if the assessment for inadequate ventilation is predicated on the same tests for the buoyancy driven ventilation so the assessment made for the pit is to classify it as a Zone 0 inside the pit as a worst case precautionary measure.

The external zoning for the pit, taken from IGEM/SR/25 [13] Table 2 is a Zone 1 extending 2m from the pit edge.

6.8 Open Pit Ventilation

Once the lid is open, the pit may be considered an open pit, therefore the level of ventilation can be considered adequate where:

$$WD^{-1} \geq 0.5$$

$$W = \text{Width of duct (m)}$$

$$D = \text{Depth of duct (m)}$$

In this case the above criterion is true (WD^{-1}=3.3), therefore the pit can be considered adequately ventilated and zoning distance X from A7.4 applies internal to the pit, which is 3m extent from secondary release source. Where the zone reaches the edge of the pit, the zone shall be taken to its full extent from the source of release in accordance with Table 1 (1.5m).

It is noted that for control of ignition sources, most onerous zoning between lid open and closed configuration shall be applied, gas atmosphere monitoring within the pit shall be carried out prior to opening of the lid.

The agreed safe access procedure can be found in section 10.6

6.9 Manual Venting Area

Manual venting is typically carried out in accordance with T/PR/HAZ/2 [39]. The extent of the vent zone for NTS pressures assuming a 25mm diameter temporary vent stack is used with a 3m tall vent tip is 7m radius and 40m high, as defined in table of T/PR/HAZ/2 [39]

These vent zones are not shown on the standard design drawings as the location of the temporary vent stack is subject to site specific conditions.

7 Civil Design

7.1 Ground Conditions

As the substantive element, the main connection chamber must adapt to varying ground profiles. The standard specified ground configuration can be observed on civil drawings PREM845-DET-0000-1001 and PREM845-DET-0000-1002, yet site-specific adaptations may require further ground remediation by the contractor in instances such as soft clay or peat. Section 7.5 defines an allowable safe bearing pressure of 25 kN/m² with the latest design in mind.

The burial of isolation valves in chambers is acceptable but subject to the water table being lower than the chamber base slab invert and lower than 1m below the finished ground level as listed in the prerequisites in section 3.8. In terms of buoyancy the design water table could be significantly higher, however such locations are not likely to be selected due to adverse and wavering conditions. Although flooding concerns have been raised throughout the project, a pragmatic approach is currently preferred as described in section 3.8.

Both parameters described above will support the adoption of this connection to the NTS in most locations. The selected locations for this type of connection will largely be dictated by landowner preference and vicinity to the NTS, however these prerequisites must be considered and adhered to.

7.2 Pit Structure Design

7.2.1 Aperture

With the requirement for an adequate access route to six operable stem extensions, an achievable standard clear opening for the pit structure was to be defined. The conceptual 80mm NB bypass arrangement was specified at 2775mm x 1750mm clear opening, however, to be inclusive of 100mm NB bypass arrangements and to boast the optimal arrangement for functional access described in section 7.4.1 at both sizes, a 3000mm x 2000mm clear opening was agreed on. A depth of 600mm was verified as the minimum suitable distance for all arrangements to allow sufficient clearance of the stem extensions to the cover.

With legacy confined space and unsafe access concerns in mind, ref section 3.6, a wider and shallower structure has resulted in a kinder throughfare for the pit configuration. Risks such as asphyxiation are eliminated with a depth of only 600mm as most of the operative's body remains above the effective ground level to achieve a working environment which is never substantially enclosed. A confined space assessment was later proven and is available in section 10.5.

7.2.2 Corrosion (Pit Wall Transitions)

The conceptual and final designs avoid pit wall transitions entirely which mitigate corrosion related issues like the examples provided in Table 2, and the maintenance challenges seen in legacy installations. This is arguably the biggest legacy concern which over time causes serious integrity and operational challenges. To eliminate this issue, the line to the customer plant will run beneath the pit with stem extensions for operable assets protruding through an open invert in an envelope of drainable backfill material provided for the chamber base.

7.2.3 Drainage

The void to the pit invert described in section 7.2.2 also serves to eliminate flooding and water accumulation inside the pit, with approximately 60% of the interior invert area acting as a passive drainage system to the native soil, and with no reliance on electrically pumped solutions.

The passive drainage system is composed of 100mm rounded stone chippings to the invert level, followed by 350mm of pipe bedding sand in accordance with British Standard BS EN 12620 [40]. A geotextile layer has been specified around the edges and underside of this above area to prevent the migration of sand.

The pipework below the geotextile layer will be bedded on and surrounded with a minimum 150mm thickness of 10mm single sized rounded aggregate. This includes the main connection line, and a 1750x2000x900mm deep column of aggregate directly below the open invert to prevent any hinderances from permeability and to ensure all rising pipework stems are captured.

The pit cover selected and discussed in Section 7.3 will reduce water ingress from above to an absolute minimum if correctly laid on a bed of sealant in accordance with requirements from the manufacturer. Water table prerequisites will eliminate the flooding of the pit in normal conditions for the shallow invert level specified.

Rare weather events inducing substantial and long-term flooding are anticipated, however the pit is expected to quickly drain when conditions start to recover. Short term flooding will not impact the design life of the connection chamber.

Straightforward maintenance procedures should be sufficient in the event of silt build up for the conservatively assumed 20-year design life of the pits. The closed pit would not suffer from collection of airborne dust and debris. With water table and ground bearing prerequisites in place to filter out unfavourable locations, conditions that could compromise the required longevity of the drainage system thus warranting severe remediation are not anticipated.

7.2.4 Material Composition

Three main techniques were considered for the buildup of the pit structure: Precast concrete, cast in situ concrete, and composite chambers/rings. Construction sequencing considerations, minimising site works, and complexity of the desired outcome have played an essential role in finding the best approach.

The following study combining market research and expected site works highlight key considerations for all three techniques.

7.2.4.1 Cast in Situ Concrete

Although a cast in situ solution is easily deployable and suited to the sporadic “one off” installations that are expected, several factors have rendered this method unsuitable for a standard approach.

Complex formwork and reinforcement bars would need to be arranged in proximity to the likely prefabricated bypass with stems. Prolonged work adjacent to such small bore pipework introduces the risk of damage to this prefabricated arrangement, for which it is foreseen that temporary supported solution would be required throughout casting and curing, which introduces challenges when carried out on weak native ground. A standard design with a universally understood installation procedure is highly preferred to this.

The vast amount of onsite activity required for a cast in situ solution may also be challenging on remote greenfield sites with often single lane tracks, limited parking, and frequent passage of large farm vehicles, none of which are ideal for the customer. The remote nature of expected sites also introduces a risk concerning the small quantity of sulphate protected concrete required without chemical testing, which tends not to be not available at batching plants.

Furthermore, the upstand cover frame specified in section 7.3 will have a thin frame width of approximately 75mm, with fixing holes 40mm from the inside edge of the pit. Drilling these holes could cause damage or splitting of the chamber structure.

7.2.4.2 Composite Chambers

Composite chamber sections are widely adopted throughout the utilities sector as a quick, cheap, and lightweight solution. Design and site considerations discourage this approach for several reasons.

Firstly, the aperture discussed in section 7.2.1 involves an unreasonably large clear opening requirement which exceeds dimensions regarding standard installation procedures for most composite chamber manufacturers. Although specialist large composite chambers are available and have been installed in the past, the presence of the likely prefabricated bypass with stem extensions will block a significant portion of the internal area for the required bracings during recommended backfill procedures, along with the simultaneous installation of the cover unit.

These bracings are a common if not essential requirement for large aperture composite chambers, which due to the shallow nature of the pit and the obstruction from prefabricated assets, will be largely constrained and liable to incorrect configurations. The step assembly can also exacerbate obstructions for bracings and may need to be installed at the very end, removing the opportunity for prefabrication.

Although composite chambers may provide a lightweight and cost effective solution for walls, a base plate will still require casting along with a concrete surround to the walls which will typically be recommended for such apertures, meaning the need for cast in situ concrete and its associated issues persist. Given the shallow 600mm vertical dimension required, the convenience of a lightweight solution is secondary, as the use of heavier concrete solutions will not induce a detrimental effect on ground bearing pressure, as opposed to deeper and more extensive structures.

7.2.4.3 Concrete Precast Unit

The multifaceted geometry required alongside technical design benefits including cast in fixings for the cover and step assembly makes this solution preferable compared to its counterparts. Given that a precast solution will be manufactured off-site in factory conditions and in accordance with the cover unit requirements, anchor points for the cover fixings and step assembly connections can be set with high precision to avoid clashes with main reinforcement bars by design.

As expected, this solution requires lifting and lowering far heavier objects in comparison to composite or cast in situ methods, which prompts health and safety concerns. At a conservative weight of 9 tonnes inclusive of the cover unit and step assembly if prefabricated, it was agreed that this practice should be achievable even in remote locations.

Prefabrication of the entire chamber off site is a significant benefit of involving a precast supplier, affirming a lean methodology for both National Gas and the connecting customer which prioritises quick deployment and minimal disturbance on site. The circumvention of specialist site works and potential delays that arise due to the sequencing issues anticipated with the two prior techniques justifies the higher cost anticipated for a precast chamber.

Given the compact dimensions of the preferred cover assembly discussed in section 7.2.4.1, the selected unit will likely be adapted for precast solutions. If a precast chamber is selected, the expertise between precast and cover suppliers can be combined and exploited to deliver an optimal pit structure which accommodates any surrounding elements, components and agreed locations for lifting eyes/hooks.

7.2.4.4 Pros and Cons Matrix

The above section has been summarised in a pros/con's matrix below:

Table 9: Pros and Cons of differing pit composition materials

Option	Pros	Cons
1. Cast In Situ Concrete	- Custom shapes achievable on site - No transportation of large units required - Cheaper when considering *one off* units or very small quantities - Employable when required, minimal lead time	- Complex formwork near prefabricated bypass - High risk of damaging small bore assets - Prolonged site works on constrained rural sites - Difficult cover fixing due to thin frame and anchor hole position - Not ideal for weak ground conditions
2. Composite Chambers	- Lightweight - Potentially lower material cost - Easier manual handling - Sustainable material	- Unsuited for very large openings - Limited bracing options with internal obstructions - Often still requires cast in situ concrete base and surround - Constrained installation and backfill procedure
3. Precast Concrete Unit	- Fully prefabricated off site in a controlled environment and includes provisions for covers, steps, and handrails	- Lifting requirements (~9 tonnes including cover and steps)

	- Accurate positioning of cover and step fixings - Compatible with EJ cover - - Collaboration and sharing of experience between suppliers - Minimal site activity required	- High cost for one-off orders

7.2.4.5 Conclusions and Decisions

The proposition for the standard material composition of the connection chamber must prove to be adaptable for different ground profiles, the alleviation of common installation challenges, and greater efficiency for both client and customer.

After careful design consideration, a precast chamber unit was the favoured option.

7.2.5 Precast Chamber Design

The final design developed with off-site and precast manufacture in mind has been shaped by both transportation constraints and technical requirements of the pit system, including integration with the preferred cover unit discussed in section 7.3.3.

A key limitation for precast units confines the dimensions of the chamber to a maximum width of 2.4m and a maximum length 4.0m to avoid abnormal load classifications during transport. Critically, units wider than 2.4m would require *Highways Agency* notification, and units longer than 4.0m would reduce transport efficiency, limiting delivery to a maximum of two units per lorry. Although units will typically be delivered one at a time, the 4m length to allow for three units per lorry was very achievable.

As such, the external dimensions of the pit had to conform to these limits while accommodating the 3000mm x 2000mm internal clear opening described in section 7.2.1. This led to the adoption of 200mm thick walls along the 3.0m aperture edges, sufficient to maintain the 2.4m width envelope, while the 2.0 m ends of the opening were thickened to 250 mm to support the additional loads imposed by the hinged twin leaves of the DEFENSO AG cover (refer to section 7.3). Despite being thinner, the 75mm wide cover frame provides ample space on the 200mm walls to position four cast-in lifting eyes or similar approved lifting points that do not interfere with the operation of the cover leaves in their respective open positions. This is essential given the chamber will be lowered into place over pre-installed valve assemblies. Naturally, this requires the cover to be open whilst lifting procedures are carried out to avoid damage to stem extensions protruding into the open chamber.

The internal pit height of 600mm has been retained from the conceptual design, having been verified as sufficient to house all 80mm NB and 100mm NB pipework arrangements. The concrete base area was widened marginally to 1250mm of the internal 3000mm dimension to allow for sufficient clearance to install the step assembly and to effectively brace the vertical walls appropriately during transportation while maintaining plenty of area for the open invert for stem extensions.

To address the asymmetric geometry and resultant eccentricities discussed in section 7.5, a 500mm wide slab extension or “lip” was added to the exterior pit base on the lighter side, increasing the ground bearing area, centralising eccentricities, and maintaining the 4.0 m transport constraint. For simplicity and to ensure robustness of the unit, the base thickness including both internal and external lips is recommended to be 250mm thick below the 600mm depth invert. Therefore, the total extents of the precast chamber are confirmed to be 4000x2400x850mm, shown in Figure 11. A detailed drawing from the precast manufacturer is now available in the latest civil packs.

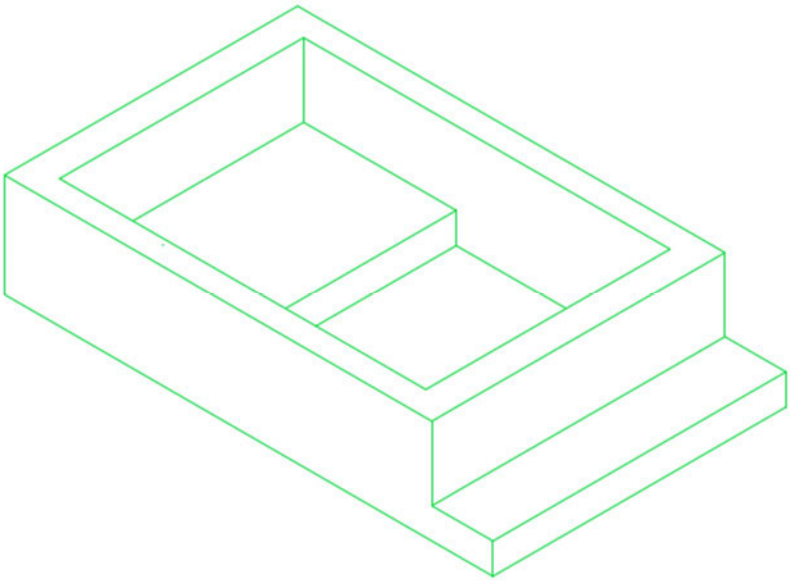

Figure 11: Isolated isometric of agreed precast chamber structure

The preferred precast supplier is expected to undertake the design and installation of an appropriate rebar cage, with cast-in channels for bolted connections of the cover and step assemblies to the top and internal walls respectively, thus ensuring accurate placement and eliminating clashes with internal reinforcement.

Cast in sections ensure isolation of the bolts from the rebar cage and lifting eyes, removing the possibility for CP interference. See section 8.3.

A 1:80 fall towards the open invert to limit the accumulation of liquid and brushed finish to the landing for the section of concrete at the base of the step assembly will be provided.

The precast concrete specification should conform to the following minimum requirements to achieve the desired design life, sulphate protection and accordance with BS 8500 [41]:

1. Compressive Strength CLASS C40/50
2. Exposure Class XC2 XF1 DC-4
3. Aggregate Size 20mm
4. Chloride Content Class CL 0.2
5. Target Density 2400kg/m^3
6. Consistence Class S2.

The final unit must be placed on an adequate bedding described in section 11.2 and shown in civil drawing PREM845-DET-0000-1003 ensuring it does not impede the permeability of the open invert.

7.2.6 Preferred Precast Supplier

Premtech has endeavoured to contact several suppliers, however interest from many quickly faltered upon realisation of the design complexity and low quantity of units that would need procuring.

Fortunately, Premtech's proposal was picked up by FP McCann's specialist precast department and was pursued as the preferred precast concrete supplier due to their strong track record in utility infrastructure, proactive design engagement, dominance of the UK precasting industry, and their compatibility with essential project components. FP McCann's experience in delivering bespoke utility chambers - including products with complicated geometries - made them well suited to support the development of a specialist connection chamber.

An important factor in the selection of FP McCann was the availability of local representatives who offered to visit and collaborate directly with the Premtech design team in office to ensure dimensional, lifting, and fixing compatibility. This hands-on approach proved valuable during early-stage development.

Additionally, FP McCann's existing working relationship with EJ, the supplier of the SR3-rated DEFENSO AG cover integral to the pit design, further streamlined integration between the pit and cover assemblies. The ability to pre-install elements such as the cover and access steps off-site at their manufacturing facility, coupled with their offer for flexible storage arrangements at their Cambridgeshire site given the nature of the project, supports a lean delivery strategy with minimal on-site disruption for a project with an unclear programme of deliveries.

These advantages combined to make FP McCann the optimal supplier. This prefabrication approach affirmed a lean methodology for both National Gas and the connecting customer that prioritises quick deployment and minimal disturbances.

To summarise, FP McCann have confirmed their ability to aid with the development of a standard precast unit that meets the following criteria:

- Availability of technical drawings suitable for civil approvals and appraisals
- Specialist reinforcement design and detailing
- Cast in fixings for access covers and step assemblies that do not interfere with the rebar arrangement
- Cast in lifting eyes in accordance with cover manufacturer
- “Type A” finish as standard on mould faces along with any trowelled surface finish
- Favourable storage arrangements
- Further prefabrication/preinstallation options for covers and step assemblies
- Conformation to concrete spec as defined in section 7.2.5
- Full integration with EJ (proven supplier relationship)

7.2.7 Preferred supplier initial quotation

FP McCann produced a quotation for 60 units on the 28th of July 2025 for the sum of [redacted] per unit. Lenient storage arrangements for

National Gas have been promised verbally.

A sub quote was provided on the 6th of August 2025 for the unit design and detailing of this singular standard chamber unit for the sum of [redacted] The output for this design only scope would include:

- Technical drawing of the unit
- Reinforcement detailing
- Fixing details
- Lifting details
- Coordination with EJ Group

This sub quote was prepared in accordance with the latest design by Premtech available in civil drawing PREM845-DET-0000-1003 Rev A, shared with National Gas on the 6th of August 2025. This is now superseded by FP McCann's detailed drawing, extract in Figure 12, inclusive of connection details for the latest cover design and fixings.

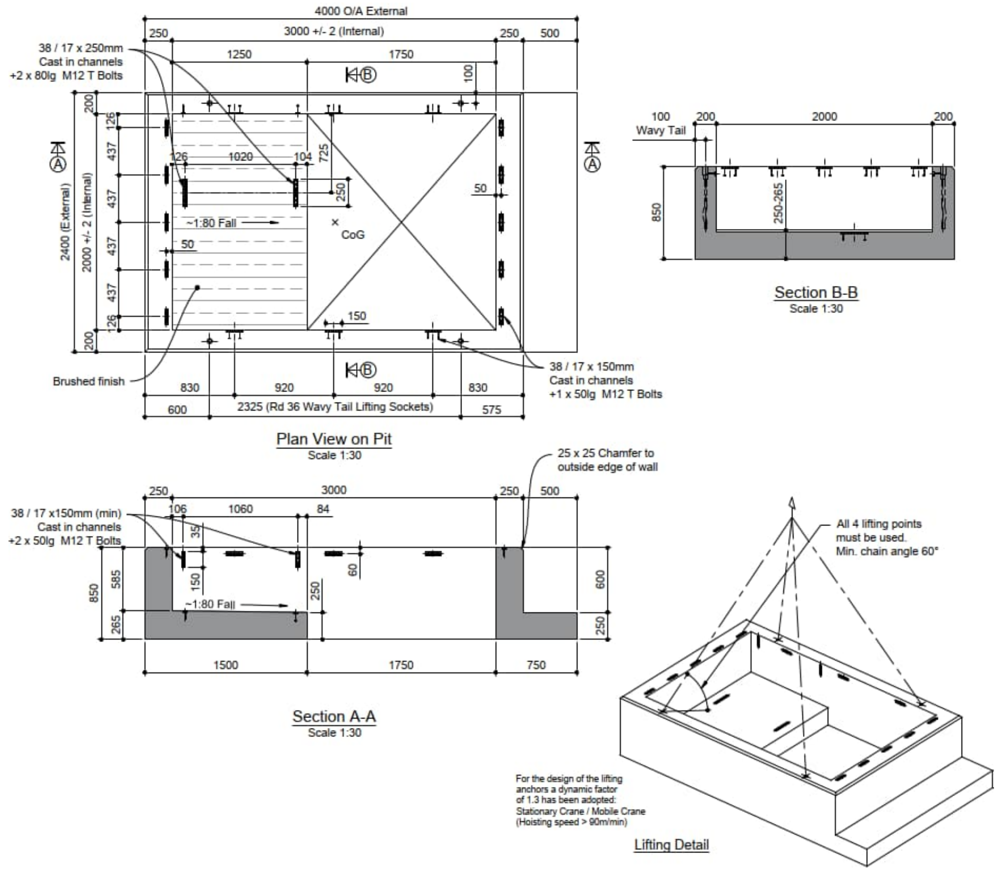

Figure 12: Latest precast chamber design – FP McCann

7.2.8 Precast Design Implications

To avoid the need for a physical corrosion protection barrier below the precast pit, a 600mm separation between the underside of the pit and the buried pipe has been deemed suitable as described in T/SP/TR/18 [14]. Although this separation distance typically relates to pipework crossings, conforming to this requirement will limit the effects of mixed potential and interaction with precast reinforcement where installed.

As discussed in section 7.2.5, the precast chamber will extend 800mm below the finished ground level. The minimum depth to crown for pipework directly below the installation has therefore been specified as 1400mm on PREM845-DET-0000-1003.

This requirement harmonises well with the notion that all minimum connections should be as close to the main NTS feeder as reasonably possible to minimise ownership, as the depth to large feeders will typically exceed 1500mm. This thereby reduces the vertical differential between the feeder and proposed minimum connection compound. If applicable, the cover to the remaining buried pipework between the minimum connection and main biomethane development can subsequently normalise to a typical depth to crown of 1200mm.

7.3 Pit Cover

7.3.1 Security Requirements

A perimeter post and rail fence and lockable covers for pit access form the basis for security provisions that align with the general design philosophy behind this innovation project.

The following minimum security requirements have been specified by the National Gas Physical Security Team:

- SR3-rated covers protecting the pits
- Shrouded padlock points on all pit covers
- Manufactured brackets on all pit covers to facilitate heavy-duty roller shutter style alarm contacts

The requirement for SR3 is derived from LPS 1175 [24] testing for the use of an allowable toolset and the minimum time taken at each security rating level to gain forcible entry through a building element. Its purpose is to establish a security strategy providing protection of items, information and systems of equipment. For SR3, this corresponds to Tool Category C, a maximum working time of 5 minutes, and a maximum test duration of 20 minutes. Investigation of this standard along with supplier discussions have confirmed that the material composition of the precast chamber discussed in 7.2.4 will not harm SR3 integrity, contrary to the fact that concrete and composite enclosures can never be accredited to SR3. Rather, such buried cases as in the proposed chamber should not be treated as an “attack point” at any rate.

To determine the required security rating for the standardised design, the National Gas Physical Security team have carried out sample risk assessment on 4 comparable locations that have been developed to conceptual design and connection offer stages.

The Physical Security team also advised there is no benefit in increasing the pit cover security level from SR3 to SR4, as this increased security rating would necessitate typical fencing and a high-security perimeter associated with standard AGIs, which conflicts with the low-profile and visually discreet intent of the pit-based connection chamber. Consequently, the provision of a post and rail fence is required to serve only for demarcation and hazardous area separation purposes. This implies that the security boundary will terminate at the SR3 rated cover if all security requirements are met.

Site specific risk assessment will be carried as part of the CDS process, and site locations with a higher security requirement than SR3 cannot benefit from this standardised design.

7.3.2 Manual Handling Requirements

The design of the pit cover must incorporate manual handling considerations to ensure safe single-person operation in line with accepted ergonomic limits. No manually operated cover leaf, handrail, or mobile element of the SR3-rated cover assembly will exceed 25 kg, allowing for lifting and manoeuvring without the need for further assistance. This limit aligns with the principles set out in the Manual Handling Operations Regulations 1992 [42], which addresses the manual handling of components and specifies ergonomic requirements to reduce the risk of injury.

7.3.3 Vehicle Loading Requirements

The loading classification of a pit cover is defined in BS EN 124 [43]. Due to the absence of vehicular access within the compound, the selected pit cover is not constrained by a minimum load class but rather by the SR3 security rating only. Aside from operation, the likelihood of slow-moving agricultural vehicles delivering detrimental impact damage is slim to none, and such cases of non-malicious intent are expected to be halted by the boundary post and rail fence in most instances. Further site specific vehicle protection may be installed if deemed necessary, allowing the cover unit to preserve a low load class of A15, commonly prescribed for pedestrian only loading environments in BS EN 124.

Although flush SR3 variants can be produced to higher load ratings, an A15 loaded upstand cover has been deemed as the optimal compromise due to the low probability of damage from vehicular axles, and the requirement for adequate ventilation points that prevent water ingress on vertical components of the upstand while maintaining SR3 certification.

Further to this, the addition of a handrail assembly later discussed in section 7.4, along with the need to maintain compliance for the access route, an upstand cover is preferred as this enables the appropriate vertical allowance for the integration of the step assembly and desired handrail storage capabilities.

On a site by site basis, additional bollards or Armco barriers can be easily incorporated in the clear space between the post and rail fence and the pit cover available due to required hazardous area separation distances. This decision to provide additional vehicle protection may be influenced by the proximity to nearby carriageways, and the frequency of large agricultural vehicles commonly encountered in arable greenfield settings.

Concern was raised by the HAZID team for an operator to inadvertently walk on the pit lid. It was that labels or stickers can be provided to deter operatives from this activity as a conservative measure, as the pit cover is already classed for pedestrian loading.

7.3.4 Atmosphere Testing Requirements

7.3.4.1 Gas Testing Equipment

To elaborate on the preference of an upstand cover, the below explanation enforces the safe access procedure described in section 10.6.

Commonly used monitoring equipment for National Gas include GMI 700 Series

Gascoseekers to detect %LEL & O_2, and Reiken Keiki monitors to detect H_2S & CO. Importantly, both are pumped units that actively pull a sample rather than relying on free airflow.

With the pit cover closed, access to the vents on the upstand frame of the cover which give a continuous passage of air must be provided. Putting the sampling tube/probe up to one of those points lets the meters draw from inside the chamber. This way, gas build-up can be checked before opening the lids. The GMI 700 comes equipped with a “Barhole mode” setting that is designed to pull samples through small apertures in such instances.

The selected upstand cover in section 7.3.6 provides adequate shielding to these vent points, which would otherwise be exposed in a flush variant, allowing for the provision of ventilation within SR3 constraints which in turn limit excessive ingress of rainwater or surface runoff. The gas probes described in this section have been agreed as suitable for use on the latest cover ventilation points by National Gas Ops, enforcing the agreed safe access procedure in section 10.6.

7.3.4.2 Spark Risk Assessment

Concerns relating to spark generation from static charge building up in conductive material within the pit cover have been raised in design comments and risk review documentation. Given that atmosphere testing shall be carried out and cleared before pits are opened, the risk associated with the small possibility of sparks is minimised.

It is not 100% guaranteed that the cover, mainly made of galvanised steel and the stainless-steel accessories will not spark when used. However, the inherent risk is very low and has been further reduced by the galvanisation provided, given it is a zinc coating applied to a soft material that does not produce sparks. If this thin layer of zinc wears away or significant impact occurs when operating mobile components, there is a very slight possibility of sparks.

All access covers currently certified to SR3 are made of steel, and therefore no alternative material options exist. The thickness of the galvanisation has since been thickened further due to corrosion concerns, section 0, therefore all but mitigating any concerns considering the low frequency of operation of said cover.

7.3.5 Market research

7.3.5.1 Initial Observations

Discussions with the National Gas security team assured there was no preference between flush, or upstand covers. Nonetheless, the selected cover type would have implications for access (see section 7.4) and could affect the feasible provision of ventilation (see section 6.6). Further design preferences have been touched upon earlier in this section.

The major constraint when investigating common access unit solutions was the 3x2m aperture requirement defined in section 7.2.1, all while conforming to SR3 requirements. Additionally, intermediate supports or recesses spanning the aperture for multi leaf systems would restrict free passage of operatives inside the chamber and were to be avoided if possible.

It was quickly understood that such a cover unit “off the shelf” would be difficult to acquire considering the above requirements. Attention was soon focused on bespoke manufacturers.

7.3.5.2 Supplier Cooperation

Bespoke designs require tailored vehicle loading sign-off to EN124 [43], with a typical lead time of 2–3 months and fee of approximately [redacted].

One proactive supplier, EJ Group [44], discovered that one of their SR3 single leaf systems could be capped at a 2000mm x 1500mm aperture within the confines of their SR3 and EN124 regulatory sign off. Hence, two such systems would satisfy the desired aperture for this design. This proposed solution abided by all above security and functional demands and led to promising discourse regarding detailed design.

7.3.6 Preferred supplier design

The selected pit cover for this design is a DEFENSO AG upstand twinleaf system manufactured by the EJ Group shown in Figure 13. This cover is approved to EN124 [43] for A15 loading.

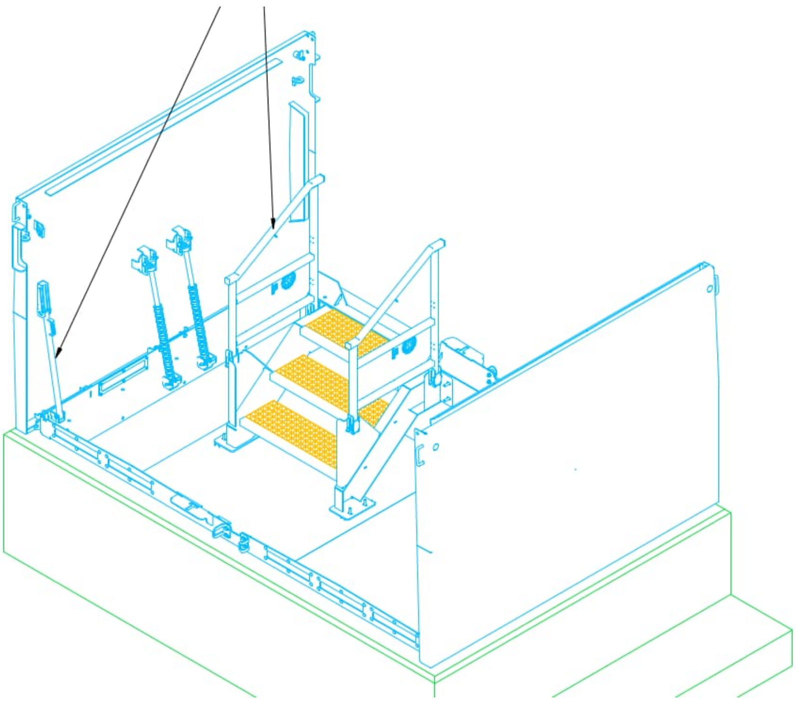

Figure 13: 3D model of the 3000x2000mm DEFENSO AG

This supplier offers the largest clear openings available for an SR3 cover with no intermediary supports or recesses that Premtech have encountered. The existing accreditation for this 3000mm x 2000mm pit cover requires a hinging leaf from both 2000mm edges, which has dictated the entry point to the 3000mm aperture edges of the chamber as demonstrated in the latest civil pack.

As EJ Group regularly provides specialist access solutions, a foldable and locking handrail system tailored to this cover design was offered and has been shown in Figure 13, alleviating access challenges described in section 7.4.

A 38mm gap between the finished concrete level and the hinged leaves has been deemed suitable for the required gas monitoring of the internal atmosphere via the provided vents in the closed position, prior to entry.

Before proceeding with an order, it is advised that the National Gas Security Team coordinate with Premtech and the EJ Group to determine the detailed specification and quantity of internal brackets required for the desired alarm bracket arrangement they intend to enrol.

The cover now features a hand operated safety blocking system, sized for the leaf dimensions. As the design is under current modifications and BRE reassessment arising from other HAZID actions, exact figures and calculations for wind loading in the open position are not available at this stage. The cover and respective blocking system are similar to existing products from the same manufacturer and will be proven suitable once documents are available. Their existing products have tested the discussed blocking system in all conditions below those of hurricane winds, which are unlikely conditions for an operative to be operating within the compound.

The current BRE reassessment will predominantly serve to eliminate the trip hazard on the upstand frame entirely, resulting in the frame being flush with the access route. This reassessment is set to confirm the cover as SR3 with the discussed modifications.

As mentioned in section 7.2.6, the 16 total provided cast in channels for the fixing of the frame must be used, and locations are clarified on the latest civil pack. Although the minimum certification for attack testing under SR3 would be 4 fixings, the design needs to compensate for the spring struts mounted in the frame which will impose tension onto the unit.

To summarise, the EJ Group has confirmed the availability of a standard 3000mm x 2000mm clear opening upstand DEFENSO AG cover unit that meets the following key requirements:

- Adequate security rating (SR3) to LPS 1175 and A15 loading to EN124
- Padlock points in accordance with SR3 and NG Security Team requirements
- Appropriate alarm contact brackets as required by the NG Security Team
- Two individually lifted torsion spring assisted leaves that do not exceed effective manual handling limits for single person operation (25kg per leaf)
- Auto 90° locking arms that do not clash with the contained assets and prevent any movement in the open position, hinging on both the 2000mm edges with appropriate design for wind loading
- Replaceable torsion spring assist mechanisms that are easily procurable
- Options for retrofit of vibration sensors
- A frame composed of S235 mild steel
- Galvanisation thickness of 140 microns
- Provision of sufficient anti insect/rodent ventilation points that satisfy the closed pit classification and required gas testing procedures.
- Provision of a bespoke handrail assembly which conforms to industry standards, the agreed cover unit, and designed step assembly
- Collaborative design and integration of 16 No. fixings with the preferred chamber manufacturer (FP McCann)
- Bespoke modifications to eliminate all trip hazards for operatives

7.3.7 Preferred supplier initial quotation

The EJ Group produced a revised quotation for 60 units on the 15th of September 2025 for the sum of [redacted] per unit. This is inclusive of the SR3 cover itself, one step assembly, one paired handrail system and one padlock + key set per unit.

EJ's Technical data sheet for this proposed design is now available in the latest civil pack.

7.4 Access and Egress

7.4.1 Functional Access

Designs must provide safe access to valve stems and pit internals via step access. As an exemplar design, it is essential that the access route strictly conforms to operational and regulatory requirements.

A singular entry/exit point is located on the corner of the pit and shall be accessed from the longer 3m side of the cover, with a bottom landing area provided by the precast unit. This ensures the entire step assembly will bear load onto the robust precast chamber unit to eliminate the risk of subsidence. Contrary to the conceptual drawings, the access route cannot be located on the shorter 2m clear openings faces, as the signed off DEFENSO AG cover requires the hinging leaves on these shorter edges for their existing BS 124 accreditation, see section 7.3.

The direction of the access route and position of the landing area has been considered against several possible pipework arrangements shown in Figure 4. The final design shown in Figure 8 was derived from "option 4" and is favoured given the ease of access from the landing area, operational safety, and to minimise the quantity of pipe covered by the precast unit. The designed arrangement for 80mm and 100mm bypasses ensure all assets that lie above the invert level can be clearly identified from one angle of perspective during maintenance and operation. As arranged, these assets neatly surround the peripheral open invert slot.

7.4.2 Step Assembly

The step assembly has been designed by Premtech in accordance with BS EN 14122-3 [45], and will be provided by EJ with minor modifications. The arrangement must strictly allow for 800mm wide access steps for maintenance and operation. Given this access route will not be subject to the usual passage or crossing of several persons simultaneously, there is no requirement to provide a clear width of 1000mm. This width requirement is respected within the chamber itself and between operable assets as shown in Figure 8.

For a height of 600mm, three steps at equal increments of 200mm have been designed, allowing the top step to remain flush with the top of the precast unit and finished ground level outside of the pit. This flush top step is especially important to adhere to standards as the top step must act as the "landing" for the step assembly as stated in clause 5.5 of BS EN 14122-3 [46], unobstructed by the modified upstand frame of the cover, eliminating trip hazards for any operative stepping into the chamber. A lower top step would require an operative to step down and inwards considerably further into the pit to avoid the precast wall which would induce a large trip hazard. With a flush precast wall and top step, a solid foothold is provided as an effective landing area at a comparable level to the exterior finished ground level.

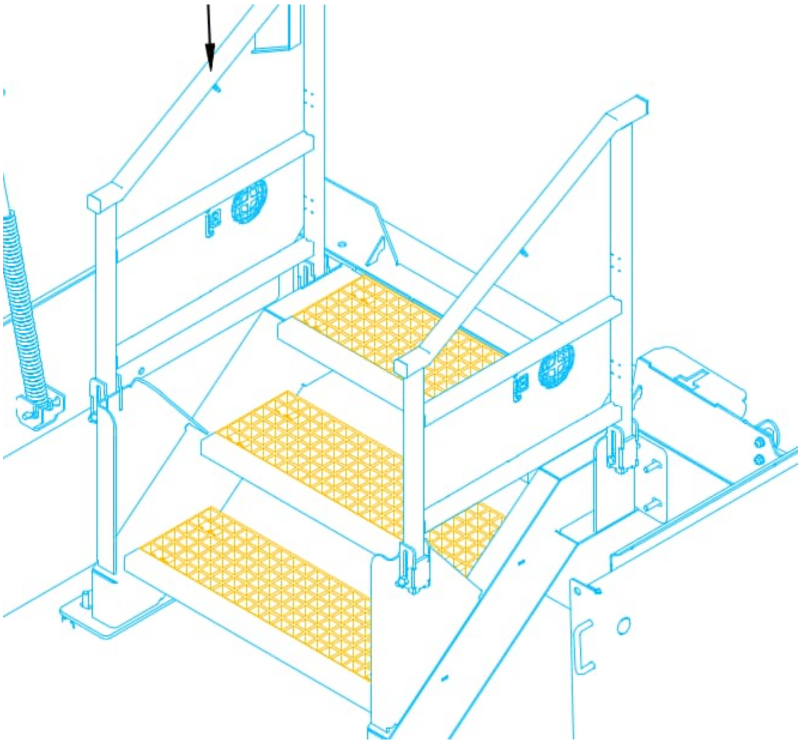

Figure 14: Isometric of complete step assembly

The supporting structure is composed of several parallel flange channels (PFC) at varying angles to allow for a suitable welding area for each step on the inside. The supporting structure must also allow for four connection plates to be fastened to the outside for the folding handrail system, also provided by the EJ Group, details in section 7.4.3. Intermediary steel plates have been welded to PFC's where necessary to accommodate this.

Anti-slip surfaces are standardised wherever operatives are expected to undergo a change in verticality, therefore a 38x38 GRP mesh will be used for step footings. These are easily replaceable panels which prevent the accumulation of water during a heavy rainfall period if the covers need to be open for operational purposes.

The EJ group have offered to fabricate the step assembly, in line with Premtech's detailed design. This will guarantee seamless integration with the handrail assembly and eliminates the involvement of an additional organisation responsible for component fabrication. The simultaneously delivery of the cover, step assembly, and handrail assembly will ease pressure on coordination and on site activities.

7.4.3 Handrail Provision

Handrails will be required for any application involving a change in verticality of 500mm or more. With further concerns and recent instances of injury raised in the National Gas risk workshop meetings, the inclusion of handrails is necessary for this access and egress route. With the requirement for a closing cover, a permanent handrail solution could not be offered, and rather a foldable or demountable system was proposed.

EJ have offered an efficient folding handrail arrangement which conforms to the internal dimensions of the upstand DEFENSO AG cover in the closed/folded position, as shown in

Figure 15,. This handrail assembly is lockable in the open position via slotting hinges which ensure an adequate rigid solution for operatives. Additionally, when folded the handrails block the access route meaning operatives must erect the handrails prior to entry, preventing any negligence to the safety measures in place.

Handrails will be provided on both sides of the step assembly with a light structure, <10kg, and intuitive folding mechanism. The handrail system is fully supported by the step assembly structure with sufficient clearance to the underside of the security cover in both open and closed positions.

Figure 15: Open & closed isometrics of handrail assembly

This standard handrail assembly features sloped rails which maintain the 900-1000mm vertical requirement from the nosing of each step to the top of the rail as stated in BS EN 14122-3 TC, clause 7.2.1.4 [45].

7.5 Ground Bearing Pressure

Due to standard application of the approved chamber system in greenfield sites, a suitable minimum local allowable ground bearing pressure must be defined. 25 kN/m^2 has been identified as a sensible figure for most cases with the below assessments in mind.

7.5.1 Bearing Analysis

Although the structural base has an extent of 4000mm x 2400mm, the design is non symmetrical. BS EN 1997-1:2004 [46], clause 6.5.5 states that eccentric loads should be considered and bearing resistance verified such that no uplift occurs. BS EN 1992-1-1:2004 [21], clause 5.8.9, permits linear pressure distribution assumptions provided that the resultant load lies within the middle third of the base. These principles ensure a reliable and safe interaction between the structure and the supporting soil, and suitability of the bearing system under combined vertical and eccentric loads explored below.

To evaluate the design with respect to vertical bearing pressure and eccentricity effects, three main loads have been considered such that the total imposed load is conservatively estimated at 9 tonnes (88.26 kN), comprising the following:

1. A 7500kg reinforced concrete precast unit with an open invert as pictured in Figure 11, including 600mm high walls and a 250mm thick base slab.
2. A 1000kg bespoke DEFENSO AG multileaf security cover, centred over the top walls and delivering load equally to all walls.
3. A 500kg step and handrail assembly, located near the corner of the pit.

Both the EJ cover and step assembly inclusive of the handrail assembly have been modelled at higher than anticipated masses to generate unfavourable eccentricity in both X and Y directions and ensure a conservative assessment with the positioning of walls and the open invert section in mind. True unit weights will be available in the relevant detailed drawings and latest supplier datasheets when available.

Treating the precast system as a homogenous entity, the mass of the precast walls and base slab can be calculated for their respective centroids via the dimensions available in section 7.2, with full details in the latest civil drawing pack. For simplicity, the corresponding mass associated to the base slab was interpolated to disregard the open invert, and an additional negative load for the cut-out was applied. The five resulting magnitudes and centroids by element are displayed in Table 10 with reference axes in Figure 16, and the overall centroid of the system was calculated. This yielded a net eccentricity of:

- -287.86mm in the X-direction ≈ 1712mm
- +33.33mm in the Y-direction ≈ 1233mm

Table 10: Individual Element Centroids

Pit Element Description	Load (kN)	X (mm)	Y (mm)
Base slab (no void)	59.49694555	2000	1200
Open invert (cut-out)	-21.6923098	2375	1200
Wall assembly	35.74523925	1750	1200
Defenso AG cover unit	9.80665	1750	1200
Step assembly	4.903325	800	1800

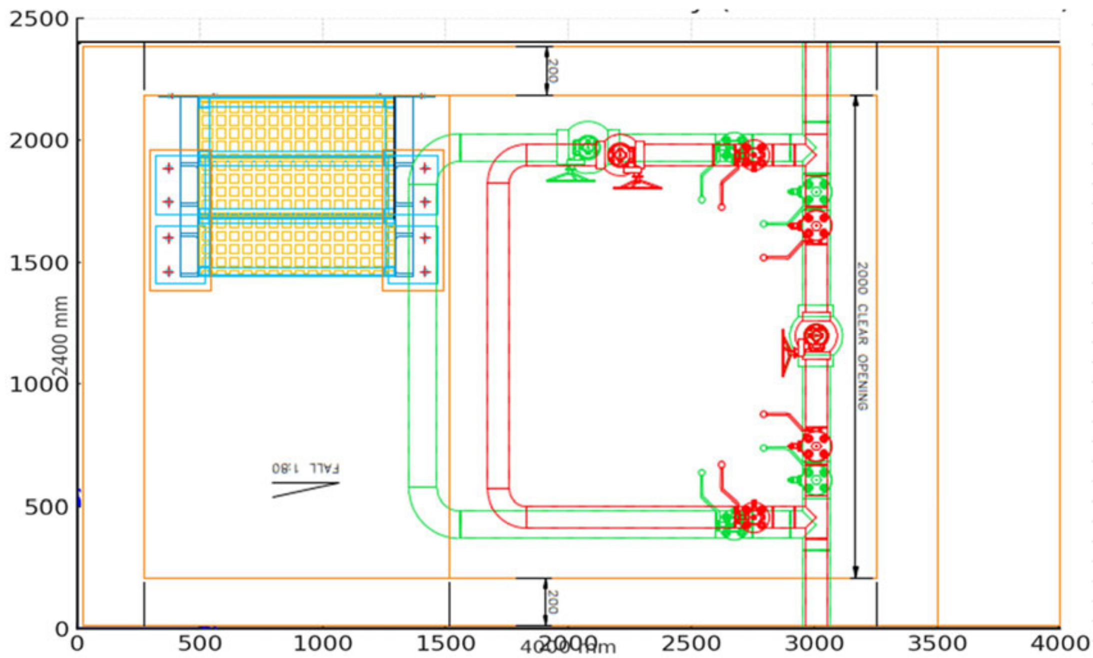

Figure 16: Reference axes for base slab geometry, H = x, V = y

With minor offsets, the resultant load remains within the middle third of the foundation in both axes, allowing for simplified design checks based on linear pressure distribution.

The effective bearing area of the base slab is 6.1 m², therefore the corresponding maximum bearing pressure is 14.47 kN/m² which is safely below the selected minimum allowable safe bearing pressure of 25 kN/m².

7.5.2 Recommendation for Ground Investigation

A recommended approach for confirming the ground conditions is a windowless sampling (WLS) investigation with standpipe installation. This method is well suited to remote or undeveloped sites where traditional cable percussion rigs may not be viable due to access or cost limitations. WLS allows for efficient shallow borehole drilling up to depths of 5 m and enables the logging of groundwater strikes during drilling. By installing a simple plastic standpipe (piezometer) within selected boreholes, the site team can monitor groundwater recovery over time to establish an accurate equilibrium water table level. This approach provides a reliable, cost-effective, and rapidly deployable solution to confirm whether site conditions meet the specified water table criteria for the pit design.

7.6 Fencing

As part of the civil scope for these standardised connections, a traditional post and rail fencing system was adopted to BS 1722-7 [47], consistent with rural surroundings and the limited security requirements of the installation. Figure 17 shows an extract from drawing PREM845-DET-0000-1005, which details this arrangement including post sizing, spacing, and foundation specifications.

The chosen system consists of 150x75mm timber posts with 87x38mm timber rails, forming a robust and well-established fence type that aligns with National Gas' rural asset boundary practices. Posts are set at a maximum spacing of 1.8 m to ensure structural rigidity and reduce sagging under load, with foundations either comprising 300x300x400mm deep concrete footings (FND4) or 600 mm driven embedment in areas with suitable ground conditions. Rails are securely fixed with galvanised nails, while barbed wire is optionally included unless the fence is adjacent to public footpaths or roads.

This solution offers the dual benefit of clear asset demarcation and minimal visual intrusion; key considerations for installations located in agricultural or greenfield settings. Additionally, a single timber wicket gate is integrated to allow access for inspection and maintenance, with standardised detailing to support consistent construction and ease of procurement.

The use of softwood timber treated in accordance with BS 8417:2011+A1 [48] for a 20-year service life further supports the long-term durability of the fence in external conditions. This specification ensures resilience against rot, insect attack, and general weathering. Simplicity and practicality were prioritised to suit potentially remote locations with limited vehicle access or heavy plant, making this fencing method both constructible and maintainable within typical operational constraints.

The post and rail boundary is to be set to surround and ensure a minimum of 3m separation from all assets in the pit or the hazardous area zone (also 3m), as detailed in clause C.1.3, note 3 of T/SP/G/37 [49] with reference to T/SP/TR/18 [14]. This proposal was raised as a technical query against T/SP/G/37 [49] during a conceptual design study where the pit concept was first used. The accepted TQ can be found in appendix A. Further details regarding boundaries and finishes can be found in section 7.8.

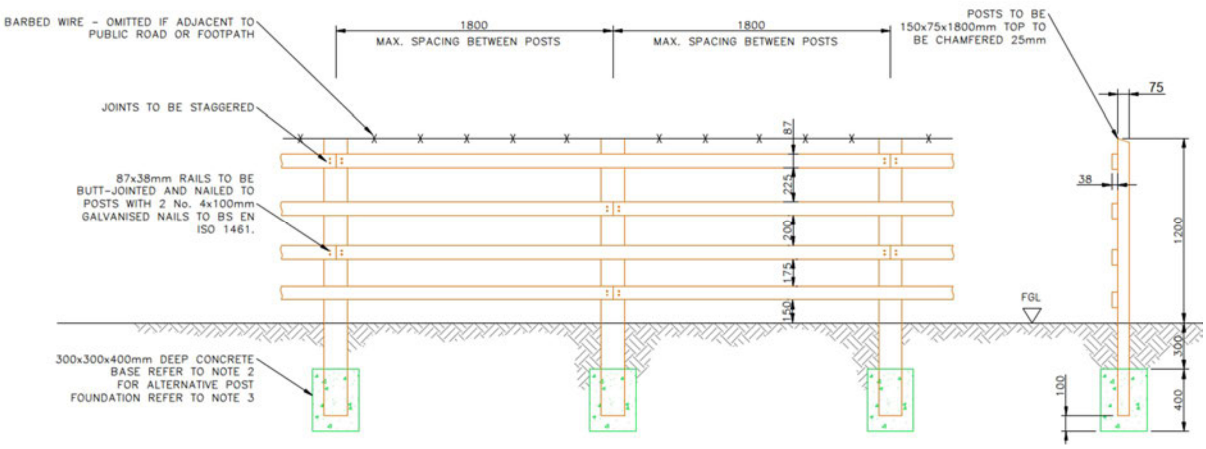

Figure 17: Typical post and rail arrangement

7.7 Roads and Pathways

7.7.1 Site Roads

The standardised design does not require the provision of dedicated access roads within the compound itself. Instead, the civil design philosophy promotes minimal intervention by encouraging the positioning of the installation compound adjacent to existing access tracks or minor roads, wherever feasible. This approach improves constructability, reduces land take, and enhances efficiency during both the installation and operational phases. The proximity to existing infrastructure supports lean delivery objectives and reduces the environmental impact of new construction.

Although no formal site roads are included in the design, it is advised that the compound be near a suitable area for the provision of a layby, or adjacent parking arrangements. This enables safe vehicle access during periodic inspection, operation, and maintenance activities. An example of such an arrangement is illustrated in drawing PREM845-GEN-0000-0012, which shows how a layby may be incorporated into the overall site layout. The provision for parking should be evaluated and agreed with local stakeholders and highway authorities where applicable. A minimum of type 1 sub-base compacted to 150 mm, topped with 50 mm well-graded gravel is recommended.

In terms of road safety and vehicle impact, consideration must be given to the nature and speed of the adjacent road, as well as the local topography and visibility. These factors influence whether additional roadside vehicle protection measures, such as concrete bollards or Armco barriers, are required to safeguard the installation from vehicles given the A15 loading classification of the cover. Such protective elements should be considered on a site-specific basis and factored into the design where necessary. Examples of roadside bollard configurations are also provided on drawing PREM845-GEN-0000-0012.

Additionally, as mentioned in Section 7.6 of this report, internal vehicle protection within the compound may be warranted in locations where slow-moving agricultural machinery or other large off-road vehicles are present. In these instances, protection can be provided through strategically placed bollards or similar physical barriers installed inside the post and rail boundary fence to prevent accidental impact with above-ground pit features. This dual-layer approach to vehicle protection ensures operational resilience across a wide range of rural deployment scenarios.

7.7.2 Site Pathways

Based on drawing PREM845-DET-0000-1008 in the civil engineering drawing pack, the gravel path design has been tailored to meet both functionality and constructability requirements for rural biomethane installations. The path serves as a basic maintenance access route within the fenced compound and does not require full vehicular capacity. As such, the design balances cost-effectiveness with adequate durability for occasional foot traffic and light manual handling activities.

The design adopts a Type 1 granular sub-base with a compacted thickness of 150 mm, topped with a 50 mm clean gravel wearing layer. This layered construction ensures sufficient load-bearing capacity and drainage performance, which is especially important on sites where ground permeability may vary. A geotextile separation layer is included at the interface with the native ground to inhibit migration of gravel and maintain sub-base integrity over time, a critical detail for remote sites where future maintenance access may be limited.

The 1.0m nominal width is optimised for single-person access and complies with the ergonomic requirements for operatives moving within the compound. Where the path interfaces with kerbs or gate thresholds, clear detailing ensures flush, trip-free transitions for safe access. The use of edge restraint in the form of 200x915x50mm concrete pin kerb edging blocks provides lateral stability to the gravel finish, helping to maintain the defined path boundary over time. The standard path shown indicatively on mechanical drawing PREM845-GEN-0000-0012 serves to connect the nearby parking provision with the post and rail boundary gate, however site specific modifications can be made where reasonable.

The construction methodology prioritises the use of readily available materials, allowing for efficient delivery and installation, even in remote or rural locations. This approach ensures that the path can be installed quickly without requiring specialised machinery or extended construction durations, aligning with this lean and rapid deployment design philosophy.

7.8 Landscaping and Surface Finishes

The landscaping and surface finish strategy for the standardised pit installation prioritises safety, longevity, and ease of maintenance, while remaining sensitive to the rural and agricultural settings where these installations are typically located. The chosen approach is to provide a finish of 75mm deep stone chippings across the entire compound area, extending 2m outside of the outermost boundary fence as required by clause C.1.3, note 1, of T/SP/G/37 [49], in turn achieving the 5m area from the pit cover in note 8, with a geotextile weed membrane below. This detail ensures a stable, free-draining surface suitable for foot traffic during operation and maintenance activities, while also delivering long-term durability with minimal upkeep.

The incorporation of a weed suppressant membrane below the stone surface aims to control vegetation growth around the installation. This not only reduces routine maintenance burdens but also mitigates fire risk, which is a particular concern for gas infrastructure in rural areas where dry grass or weeds can accumulate near sensitive assets.

The granular finish ensures compatibility with drainage design principles discussed in earlier sections of the report and supports passive infiltration of rainfall while avoiding the need for complex hard surfacing or kerbing.

8 Corrosion Protection Design

8.1 Corrosion Risks

As identified in section 3.6 there are increased corrosion risks associated with pipework and valves located in a pit which have been mitigated by design of this pit.

The pipework is located under the shallow pit construction thus avoiding the need to install a pipe through a pit wall transition.

The pit floor is not solid concrete; the base material is free draining such that rainwater cannot be retained in the pit chamber.

Further details relating to these design mitigations are covered in section 7.2.2 and 7.2.3

As stated in section 3.8 there is a limitation of use for this pit to areas where the ground water table is lower than 1m.

During the safety studies there were various corrosion related risks raised relating to the coating and galvanisation deterioration of pipework and pit cover components. Appropriate levels of protection have been established in earlier sections of this report for all elements at risk.

8.2 Pipe Coating and Painting Systems

All pipework and fittings will be fusion bonded epoxy coated in accordance with T/SP/CW/6 [50] to prevent corrosion. This coating system is selected to protect the small amount of above ground pipe and fittings from the potentially damp enclosed pit atmosphere. These fittings are normally under cover of the pit lid so it would not normally be exposed to ultraviolet light which can degrade T/SP/CW/6 [50] epoxy coating systems.

Wind and water lines associated with the vents and valve stems shall be treated with additional MCL coating over the fusion bonded epoxy coating in accordance with GIS/CW/5 section 7.3, for a minimum of 500mm below the ground level and to cover all exposed stem extensions, vent lines and valves.

8.3 Cathodic Protection

There is no specific Cathodic Protection detailed design associated with this standardised design.

8.3.1 Cathodic Protection – Design Requirements

The pipework arrangement includes an insulation joint adjacent to the hot tap tee connection to the feeder and one at the customer tie in point. The site specific design shall be responsible for including cathodic protection for the section of pipework between the two insulation joints.

With reference to T/SP/CP/7 [51] section 5.6 the IJ at the tee location shall be installed but subject to an evaluation of the adequacy of the upstream pipeline CP system to protect the additional MOC pipework, the IJ can be cross bonded or a resistive bond may be installed. If bonding the IJ is not suitable an independent galvanic or impressed current cathodic protection system will be required, which will be designed in accordance with T/SP/ECP/7 [51].

The designer shall send a site specific TQ to National Gas, if the insulation joint is to be bonded or resistive bonded to confirm it is acceptable. The designer shall include analysis of the existing pipeline cathodic protection system and the impact of adding the MOC.

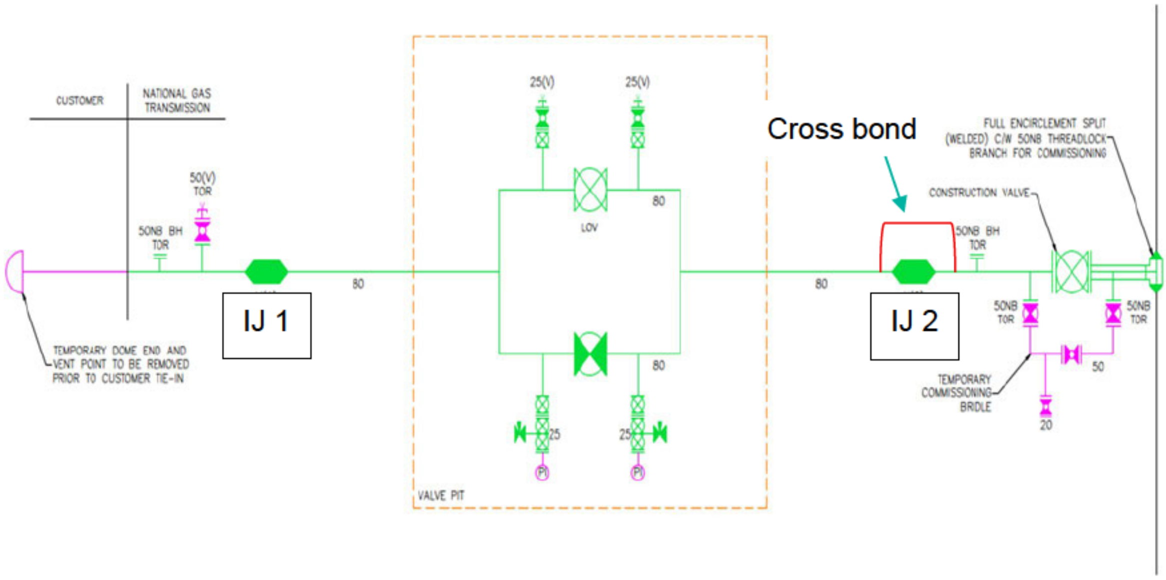

Figure 18: Insulation Joint Locations

Insulation Joints will be in accordance with National Gas specification T/SP/E/56 [31] and the IJ datasheet can be found in Appendix E. Monitoring facilities shall be provided for the two insulation joints for either side of the joints in accordance with T/SP/ECP/7 [51], if a bond is required this shall be within a dedicated test post to allow for ongoing maintenance and monitoring.

Recommended separation distances of 600mm have been conformed to between the main connection line and the underside of the pit to avoid the additional need for physical protection, and to limit the effects of mixed potential and interaction with reinforcement when installed as mentioned in section 7.2.8. To allow for monitoring of the pipework which is below the pit it is recommended that the pipeline test post (pipework between the two IJs) associated with the insulation joint shall have its coupons and reference electrode installed beneath the pit during construction.

The step assembly, and nearest protruding pipework stem should be cross bonded to the cover frame with typical earthing cable and pin brazes where required. It is also recommended that the cover frame is cross bonded to both leaves via a tinned copper braid for durability under movement. Possibility of a CP drain will be mitigated via design as described in 7.2.5

8.4 Pit Cover Coating Requirements

The pit cover and associated steel components are protected by hot-dip galvanising, with a specified coating thickness of 140 μm, which is the maximum level offered by the manufacturer. The selection of this coating thickness has been informed by the anticipated exposure conditions and applicable corrosion standards in recent FPSA studies.

In accordance with BS EN ISO 9223:2012 [52] most proposed installation locations are expected to fall within Category C2, characterised by rural environments and unheated, intermittently damp conditions as seen in Figure 19. This assumption is supported by the typical positioning of the National Transmission System and the location of prospective connection sites, which are generally non-coastal and remote from industrial pollution sources.

Category	Corrosion Rate (First Year Thickness Loss for Zinc)	Examples of Typical Environments
C1	$\leq 1.3\mu m$	Indoor, clean atmospheres (e.g., offices, schools)
C2	$> 1.3 - 25\mu m$	Rural areas, unheated buildings with condensation

Figure 19: Worst Case Corrosion Rates

While the pit design incorporates a passive, drainable base that may allow intermittent condensation, continuous wet conditions are not anticipated except in locations subject to poor drainage or regular flooding, which would be typically rejected in preapplication. The provision of a 140 µm galvanised coating therefore provides a conservative margin of durability, well beyond the minimum required for C2 exposure over a circa 20 year design life, remaining robust even under occasional high moisture conditions.

A pragmatic maintenance approach should be also adopted, as with exposed pipework. During routine inspections, the internal condition of the pit and cover should be visually assessed, and where any build-up of algae or biological matter is observed, appropriate cleaning measures (such as a biocide wash) can be requested. As a last resort, the pit cover can be removed and replaced with relative ease.

8.5 Ongoing Inspection and Maintenance

To prolong the operational life of the asset, regular inspections and preventative maintenance shall be carried out. Recommendations are described in section 4.9.3

9 Environmental Considerations

The below assessments are based on logical comparisons only. Given the scale and nature of the installation, a detailed carbon assessment is not considered necessary to demonstrate the relative environmental benefit.

9.1 Physical Footprint

The proposed standardised pit arrangement significantly reduces land take compared with a conventional Above Ground Installation (AGI). A typical AGI layout would occupy in the region of 600-800m² within the security fence, whereas the compound shown in the latest civil design pack requires only 72m² inside the post and rail boundary. This represents a substantial reduction in footprint, minimising permanent land use and associated disturbance to agricultural or greenfield environments.

9.2 Carbon Footprint

A simplified layout directly reduces the carbon footprint of construction. The design avoids the need for site roads, hammerhead turning areas for vehicles, tall perimeter fencing, and heavy civil foundations. Instead, the pit-based solution uses a single precast structure with a lightweight post-and-rail boundary. Fewer vehicle movements, less excavation, and a reduced materials requirement all contribute to lowering embodied carbon compared to traditional AGI construction.

9.3 Visual Impact

The new design greatly reduces visual impact. Above-ground structures are limited to a 3m x 2m security-rated cover and a low wooden post-and-rail fence for the new standardised proposal. In contrast, an AGI would typically require 2.4m high security fencing and visible above-ground pipework and valves. The low-profile design is unobtrusive, blending more effectively into rural or agricultural landscapes while still meeting functional and security requirements.

9.4 Environmental Commitments

This project's philosophy aligns with the National Gas Environmental Policy (2009) [53] and its relevant commitments, including:

1. "We will reduce the effect our activities have on the environment by considering the whole life environmental costs and benefits in our business decisions."
2. "We will look for ways to use resources more efficiently through good design, use of sustainable materials, responsibly refurbishing existing assets, and reducing and recycling waste."
3. "We will reduce the impact of our business on global climate change targeting a decrease in our emissions of greenhouse gases by 45% by 2020 and 80% by 2050."
4. "We will respect the environmental status and biodiversity of the places we work, aiming to enhance areas for the benefit of local communities or the natural environment."

10 Health and Safety

10.1 General

Health and safety issues will be addressed throughout the design and construction of the project. The modifications will be constructed in accordance with current health and safety legislations, including the Health and Safety at Work Act [6], the Construction (Design and Management) Regulations 2015 (CDM) [5] and the management of Health and Safety at Work Regulations.

10.2 CDM Roles and Responsibilities

Table 11 – CDM Roles and Responsibilities

Role	Organisation	Contact (s)	Remarks
Client	National Gas	[redacted]	
Principal Contractor	N/A	N/A	
Principal Designer	Premtech	[redacted]	Design Manager
Designer	EJ Group	[redacted]	Security Cover Supplier
Designer	FP McCann	[redacted]	Precast Pit Supplier

10.3 Risk Workshop and HAZID Worksheets

Relevant worksheets are available in appendix A for several sessions as listed in section 2.2, chaired by Naeem Bhola to produce action summary sheets managed by Kelvin Shillinglaw.

The risk workshop provided valuable input into the developing design and risks were re-evaluated during the FPSA workshops.

10.4 Formal Process Safety Assessments (FPSA)

The detailed design was subject to formal process safety reviews as listed in table 13. The studies identified several actions directly related to the design. Responses to these design actions have been provided in the worksheets in appendix A and design documents updated accordingly. Formal close out of these actions is required by National Gas Safety Team.

Additional actions were recorded which do not have implication on the design but do relate to customer connections and customer connected systems, these shall be addressed by National Gas outside of this project.

Table 12 – Summary of FPSA's Completed

FPSA	Specification	Independent Chairperson	Date Completed
HAZID Day 1	T/SP/HAZ/8	Naeem Bhola	04/11/2025

HAZID Day 2	T/SP/HAZ/8	Naeem Bhola	05/11/2025
HAZID Day 3	T/SP/HAZ/8	Naeem Bhola	03/12/2025
HAZOP	T/SP/HAZ/7	Naeem Bhola	03/12/2025

10.5 Confined Space Assessment

Given the pit's shallow depth and relatively open design, the risk factors that typically necessitate confined space classification are not present. As defined in the Confined Spaces Standard NGUK/SHE/18 [54], a confined space must be both substantially enclosed and present a foreseeable risk of serious injury from specified hazards such as toxic gas, explosion, or drowning. This installation is shallow, well ventilated, and lacks such risks.

The assessment has **not** defined the arrangement as a confined space under the Confined Spaces Regulations 1997 [55].

The SCO 91 Confined Space Supplement 2024 V2.1 was completed by Enzo Armellini and issued to Naeem Bhola on Wednesday 09/07/2025 and revised on 15/09/2025 in response to minor comments from Naeem Bhola, available in appendix A.

10.6 Safe Access Procedure

Prior to the opening of any below-ground valve chamber, suitable atmospheric testing is required to confirm safe conditions. National Gas operations typically utilise GMI Gasurveyor 700 series gas detectors, which measure %LEL (Lower Explosive Limit) and oxygen levels, and Riken Keiki monitors equipped with air pumps to detect H_2S and CO concentrations.

Although the free CSA of the 10 provided ventilation points satisfies the 2% of aperture as discussed in section 6.7.3, the geometry of the upstand cover leaves may promote a very mild buildup of gas in the unlikely event of a leak. Due to the security requirements set out in section 7.3.1, simply having a grated cover will not be possible. The proposed cover upstand cover assembly allows for a 38mm gap where a gas probe for the desired equipment can be positioned in proximity to the vents.

Feedback on the proposed testing method was provided by Stuart Holt (National Gas Operations), who confirmed that the above equipment aligns with existing operational practice. Based on this feedback, the agreed procedure presented as Table 14 below has been developed to guide operatives through pre-access gas monitoring using the Gasurveyor 700. This procedure can be followed to complete the leakage survey discussed in section 4.9.2.

Table 13: Recommended Gas Testing Procedure

Stage	Procedure
Preparation	• Carry out a bump test and fresh-air zero on the Gasurveyor 700 before starting. • Fit probe and tubing securely.
Approach the Pit	• Inspect cover and vents for obvious damage or blockage. • Position yourself upwind where possible.
Sampling	• Place the probe under the cover lip centrally over the three concentrated vent points (operators must be familiar with pit drawings). • Select “Barhole mode” to optimise pump draw for trace detection. • Hold the probe in place for at least 60 seconds to allow purging and stabilisation.

Readings	• Observe methane readings in ppm/LEL range, and oxygen if fitted. • If trace gas is detected, continue to monitor until stable; if levels climb, repeat on the opposite side (other three vents) for confirmation. • If no gas is detected after two vent samples, record as "clear."
Action	• If any explosive range (LEL/vol%) readings are detected, stop work and escalate per procedure. This would require a purge of N_2 & O_2 to remove the explosive content and to safely open the enclosure lid. • Only open the cover if readings are clear at both triple vent locations.
On Opening	• Stand clear while opening, allow additional venting, and re-test directly above the pit before entry or valve operation.

10.7 CDM Risk Register

A CDM risk register has been assembled and is provided in Appendix B.

11 Site Works

Due to the standardised and innovative nature of this project, it is not possible to prescribe detailed site works arrangements within this report. Instead, these must be determined on a site-by-site basis when the design philosophy is applied to future connections.

Key considerations such as plant protection requirements, temporary works design, site establishment, buried services, site security, and traffic management will depend heavily on local ground conditions, the depth and alignment of the NTS pipeline, and the surrounding environment.

This project assumes the competency of National Gas and the appointed main works contractor to assess and implement suitable arrangements during delivery, recognising that such matters fall outside the scope of a standardised design package and must be resolved individually for each connection location.

Selected procedures relating to site works have been noted below.

11.1 Pre-Construction Surveys

11.1.1 Water Table Study

Aside from elementary visual surveys undertaken during early application, an intrusive water table survey will be required to ensure the water table is below the threshold discussed in section 7.1 for the standard pit installation.

A singular slotted standpipe & water level/pressure logger such as a Solinst Levelogger 5 [56] is recommended. This is well suited for the shallow depth range required (0.5–5m), can log data unattended for 3-6+ months during the application process, and allows for straightforward data retrieval (USB) without need for telemetry.

In practice, the logger is installed in a simple 50-100mm PVC standpipe with the sensor placed at depth and the vented cable running to a wellhead at ground level. Data will be collected on a chosen schedule, e.g. every hour, then retrieved on site by connecting a laptop via USB to the wellhead. The readings can typically be input via free software from the manufacturer and/or exported to a csv file.

Ideally, the survey should be completed during wetter months such that the highest local water table is observed.

11.1.2 Under Pressure Connection

During site specific detailed design, the location of the hot tap connection to the NTS Feeder will need proving via trial hole investigations. Excavations on to feeder will be carried out to determine its location, depth and alignment, also identifying seam and girth weld locations, pipe ovality and material conditions. Sampling and testing requirements are defined in T/PM/Q/10 [57] – Management procedure for the sampling and testing of steel pipe and fitting materials used in gas pipelines and pipework designed to operate at pressures above 2 Bar.

The size and extent of the pits required along with the tests that need to be performed, will require the pits to be left open more than one working day. The excavation ground conditions, pit walls, steps etc should be continually assessed by the MWC (daily as a minimum).

As a result, a 2m High Heras security fence will be required to surround the trial pits with a minimum distance of 6m between the fence and excavation.

Access and Egress from the pits should by via "Groundforce Shorco StepSafe" temporary self-levelling site stairs or similar.

All excavations within the vicinity of a HP gas pipeline must conform to:

T/PM/SSW/2 [58] – Management Procedure for Safe Working and Development in the Vicinity of National Gas Pipelines and Associated Installations / Requirements for National Gas.

T/SP/SSW/22 [59] – Specification for safe working in the vicinity of National Gas Transmission high pressure pipelines and associated installations – requirements for third parties.

11.2 Excavation and Backfill

Excavation and backfilling will follow the guidance of IGEM/TD/1 Edition 6 [2] and T/PR/SW/1 [60].

The prefabricated MOC pipework arrangement shall be lowered in to excavated trenches; backfilling of the excavated areas should follow soon after the installation of the new pipework.

There shall be a bed of earth, sand or other suitable material to a minimum depth of 150 mm beneath the pipe. Fine grade material free from sharp-edged stones shall be filled and compacted carefully around the side of the pipe and to a minimum consolidated height of 150mm above the pipe.

The final unit is to be placed on a level, compacted granular sub-base finished with a blinding layer to the bearing area which does not impede the permeability of the open invert. Backfill details in proximity to the chamber are shown in the latest civil drawing pack.

All works are to be verified against in-situ ground conditions outlined in section 7.1 prior to installation. Provided these recommendations are followed, the unit is expected to meet all stability and geotechnical performance criteria for safe operation.

11.3 Buried Flange Encapsulation

The proposed under-pressure connection installation and custom tie-in arrangement will result in some permanent buried flanges; these shall be encapsulated following the relevant sections for GIS/CW/6 [61].

Preparation for the encapsulation will include surface preparation as per GIS/CW/6 [61] Section 9 followed by application of a Multi-component Liquid in accordance with GIS/CW/6 [61] SCA6 or SCA7.

Once the MCL system has fully cured and been tested, a 3-part grease-based system will be applied to certain areas where you may have points of ingress or voids that need to be filled. Once complete, the valve will then be backfilled.

The 3-part grease-based system consists of a:

- Priming paste – rust inhibitive paste (which can be applied over the MCL).
- Apply grease-based tape – petrolatum tape (fully circumferential) in accordance with GIS/CW/6 [61] SCA6.
- Self-adhesive tape overwrap (fully circumferential).

11.4 Physical Isolations

The mechanical design has considered isolation requirements in line with T/PM/TR/17 [61] – *Management Procedure for Isolation of Above 2 Bar Plant and Equipment.* This shall apply the Minimum Company Standard Isolation, which uses a double block and bleed during construction and is based on the following construction sequence.

- Construction of hot tap tee arrangement, including a vapour bag connection and IJ.
- Construction of MOC pipework including ball valve and bypass pipework, along with customer tie-in pipework up to a dome end connection.
- ***Isolation 1*** – Tie-in weld between hot tap and MOC pipework carried out using construction ball valve, vapour bag and open vent in between.
- Commission pipework up to dome end – construction valve open.
- Remove construction valve temporary bridle arrangement, insert completion TOR plugs, encapsulate flanges and fittings and backfill hot tap pit.

In addition, secondary isolation in the form of safety vapour bag points have been included to reduce risk during hot works. The Main Works Contractor shall be responsible for developing site specific detailed construction and isolation plans.

Once customer has proven readiness for commissioning, Isolation 2 can be put in place.

- ***Isolation 2*** – MOC ball valve and bypass closed and cavities vented. Downstream pipework vented and purged. Vapour bag inserted local to dome end.
- Dome end can be cut out and end prepared for welding on the customer pipework.
- This welded connection will be a golden weld and subject to additional NDT inspection in accordance with T/SP/NDT/2 [37]
- Vapour bag and vent removed, and completion TOR plugs installed, encapsulate flanges and fittings.

Once complete, construction can then progress onto customer commissioning.

11.5 Commissioning

No commissioning activities shall be carried out until all relevant Completion Certificates have been approved by National Gas. All records shall be in accordance with T/PM/RE/18 [62].

Any commissioning with the involvement of cathodic protection shall take place after all welding, coating / painting, pipe supports, wiring and civil work has been completed. This shall include the performance of the insulating joints.

Connections will be commissioned in accordance with T/PM/TR/30 [63]. The Customer connection, mechanical, electrical and signal interfaces and facilities will be commissioned in accordance with T/PM/TR/47 [64].

11.6 Records

The main works contractor should provide suitable red line markups for the issue of as built drawings following completion of the works.

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13 Appendices

13.1 Appendix A: Received Documentation

Document Title	Document Number	Rev	Included (Y/N)
Decision Support Paper	NTS_23001	V2	Y
RIIO-GT3: Break out of pits – 06.06.2025	Extract from NGT_EJP02 & NGT_EJP02	-	Y
NG Confined Spaces Standard	NGUK/SHE/18	-	N
Building the Future of Renewable Gas 19.05.25	-	-	Y
Confined Space Supplement 2024	SCO 91	V2.1	Y
Biomethane Entry Exit Connections Risk Review Workshop Actions Summary Sheet - Rev 3 – 22.09.2025	N/A	3	Y
EB End of the Network arrangements 01.04.2025	EB###	V4.0	Y
Biomethane Entry Exit Connections Standardisation HAZID Worksheet – Rev 3 – 09.01.2026	N/A	3	Y
Technical Query : separation distances between pit and post and rail fence.	PREM777-TQ-0001	02	Y

Note: Not all received documentation has been included within this report so that the report is a size that can be sent via email.