

# Engineering Specification for

## The Design, Construction and Testing of Civil and Structural Works – Geotechnical, Ground Works and Foundations

**GD/SP/CE/2**

**Issue Date: July 2019**

*This document is a reference document within The Company Safety Case, all changes to this document shall be notified to the Head of SHES before any changes are initiated.*

## Version Control

### Implementation date

July 2019

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July 2024

### Document owner

Engineering

### Management approval

Head of Engineering

### Disclaimer

This safety and engineering document is provided for use by Cadent Gas Limited and such of its contractors as are obliged by the terms and conditions of their contracts to comply with this document. Where this document is used by any other party it is the responsibility of that party to ensure that this document is correctly applied.

### Mandatory & Non-Mandatory requirements:

In this document:

**Shall:** Indicates a mandatory requirement.

**Should:** Indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment must be completed to show that the alternative method delivers the same, or better, level of protection

**The Company:** Any reference in this document to 'The Company' shall be taken to mean Cadent Gas Limited.

## Document History

Description	Date	Reference
First issue	June 2009	T/SP/CE/2
Updated to account for Structural Eurocodes Implementation	January 2014	T/SP/CE/2
Cadent rebranding and minor editorial modifications.	July 2019	GD/SP/CE/2

## Key Changes (Identify the changes from the previous version of this document)

Section(s)	Amendments
All	Cadent rebranding, clarifications, reference update and minor editorial modifications.
Section 1	Updated document to incorporate: Structural Eurocodes requirements, CDM definitions and revise design life definition.

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## Document Summary

### Purpose

This work procedure was approved by the Head of Engineering, in July 2019 for use throughout The Company.

**Users should ensure that they are in possession of the latest edition and related bulletins by referring to the document library of Safety and Engineering documents available on the company Infonet.**

Compliance with this safety and engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

This Specification for “The design, construction and testing of civil and structural works – Geotechnical, ground works and foundations” is part of the suite of Specifications noted below:

GD/SP/CE/1	General	Specification
GD/SP/CE/1	General - Appendix A	Specification
GD/SP/CE/2	Geotechnical, ground works and foundations	Specification
GD/SP/CE/3	Fencing	Specification
GD/SP/CE/4	Equipment enclosures and pit covers	Specification
GD/SP/CE/12	Pipeline protection slabs	Specification
GD/SP/CE/13	Technical Security Specification for Integrated Security Solution Sites and Alarm receiving centre	Specification
GD/SP/CE/14	Horizontal Directional Drilling (HDD)	Specification

### Responsibilities

This document applies to all those working directly for The Company e.g. employees, or under the direction of The Company, e.g. contractor mate working in a direct labour team.

## 1 GENERAL INTRODUCTION

### 1.1 Introduction

1.1.1 The “Specification for the design, construction and testing of civil and structural works” is made up of a suite of separate Specifications. It provides design and construction requirements for all new works and modifications to existing assets which include the structural design of buildings and civil engineering works, as well as geotechnical aspects.

1.1.2 Any deviation to the Design, including non-adherence to the Specifications and drawings, or, use of innovative products where no recognised publications exist, shall be recorded, approved and appraised in accordance with GD/PM/GR/2: “Procedure for the technical assessment of deviations, concessions and variants”.

1.1.3 It is recommended that this document is read in conjunction with the Ground Movement suite of documents which provide guidance on effects and calculation of ground related hazards on pipelines:

GD/SP/GM/1	Specification for the Protection of Pipelines from Ground Movement and External Loading. External Loading on Steel Pipelines and Buried Piping at Installations
GD/SP/GM/4	Specification for the protection of steel pipelines operating at pressures above 7 bar subjected to vibrations caused by blasting, piling or demolition
GD/SP/GM/8	Specification for Monitoring and Measurement of the Effects of External Loads on Pipelines

### 1.2 Scope

1.2.1 The Specification covers the design, construction and testing buildings and civil engineering works associated with onshore Cadent sites and defines the minimum requirements for design, materials, workmanship and testing of the works. It is intended for use only within United Kingdom.

1.2.2 This Specification lays down a framework and defines certain terms and assumptions, by which this “Specification for the design, construction and testing of civil and structural works” as a whole is based. It shall be read in conjunction with all other relevant documents in this suite and relevant technical publications produced by The Company.

1.2.3 This document covers excavation / backfill, foundation analysis, soil / pipe interaction, analysis of pipeline “special structural sections”, ground investigation, piling, tunnelling and blasting.

1.2.4 The Specification excludes any additional measures that may be required to reduce the risk of damage from earthquakes. The Company seismic policy shall be applied and any additional measures arising from the seismic policy shall either, by preference, be instructed in the project brief, or alternatively agreed with The Company as a Deviation to this Specification.

### 1.3 References

1.3.1 This Specification makes reference to other documents including European, British and International Standards. Unless otherwise specified at the time of Tender, the latest editions of such documents, including all addenda and revisions, current at the date of the Tender issue shall apply.

1.3.2 The Company documents are revised, when necessary, by the issue of new editions. Users shall ensure that they are in possession of the latest edition by referring to the Safety

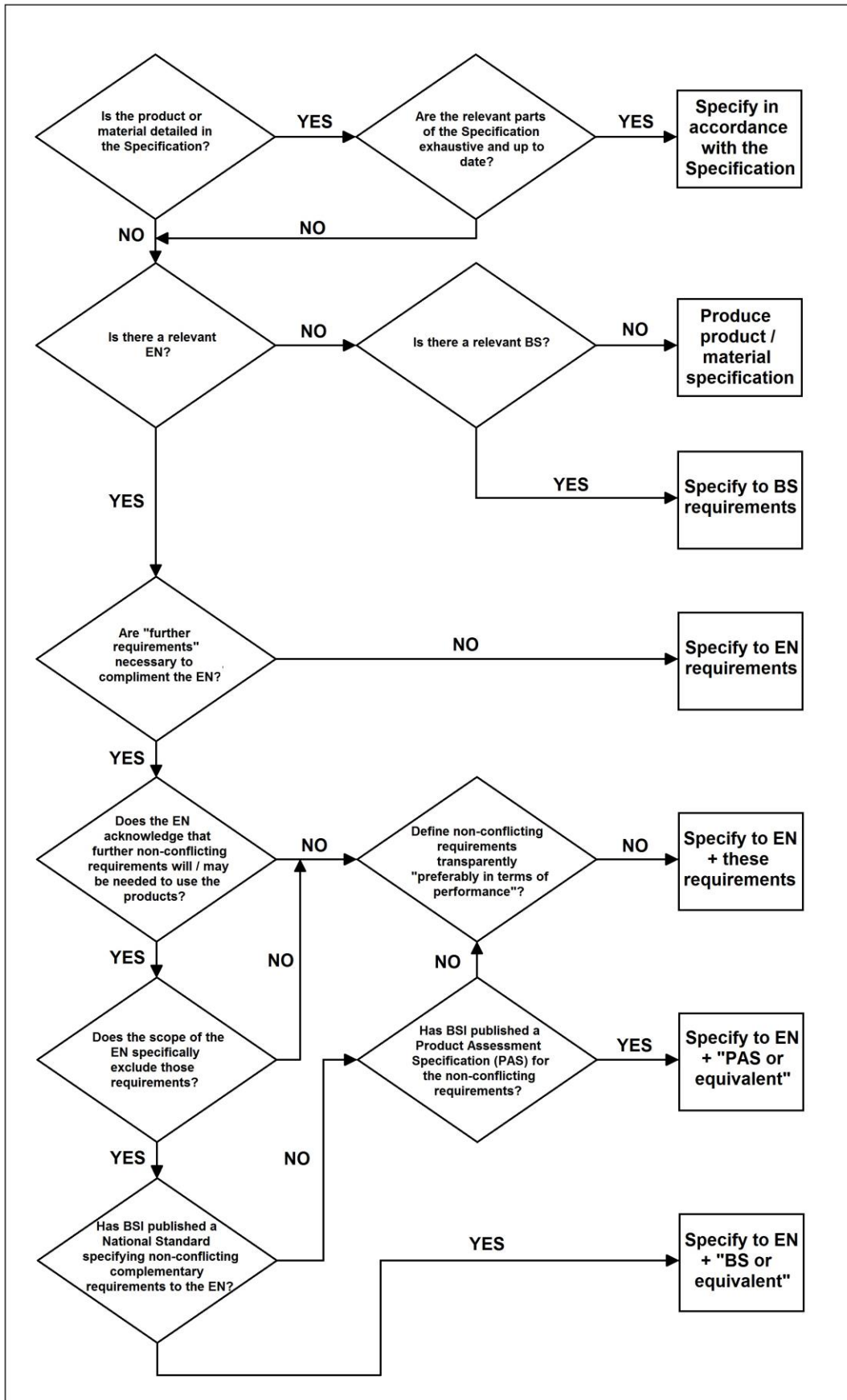


and Engineering Documents Library available on company intranet. The Company documents shall take precedence over any other documents other than statutory or legal requirements.

- 1.3.3 Compliance with this Document does not confer immunity from prosecution for breach of statutory or other legal obligations.
- 1.3.4 It shall be the responsibility of the Designer to check the validity of this Specification in relation to the requirements of the specific projects' and propose any variations through the deviation process.
- 1.3.5 Parts of this Document utilise the reference "Manual of Contract Documents for Highway Works, Volume 1 – Specification for Highway Works" by the Highways England. Reference to the "Overseeing Organisation" shall mean The Company. Where options are given in the reference, the options for the relevant country shall be used. Where the reference cites an "Appendix", the Contractor shall examine the Design Output Package for information, which shall have been completed by the Designer and checked and approved.

## **1.4 Material and product specifications**

- 1.4.1 Any specifications by the Designer or proposals by the Contractor shall comply with the Utilities Directive. This means such work shall utilise European Standards, where they exist. Such European Standards shall include national standards incorporating European Standards, common technical specifications and national technical specifications subject to the Construction Products Regulation.
- 1.4.2 Where requirements are not specifically excluded from the European Standards, or, where non-conflicting requirements need to be specified, these requirements shall be specified together with European Standards.
- 1.4.3 If European Standards do not exist, or are inadequate due to their incompatibility, or technological advances have occurred since the standards were created, current British Standards or equivalent shall be used.
- 1.4.4 Where European Standards, British Standards or equivalent do not exist, recognised, approved industry specifications shall be used.
- 1.4.5 Where a Code of Practice is stated in this Specification, the recommendations of the Code of Practice shall be complied with unless a standard to the contrary is stated and exists. Similarly, where the Code of Practice states details in the commentary, this shall be complied with where no standard exists.
- 1.4.6 A flowchart of the material and product specification procedure is illustrated in Flowchart 1.



**Flowchart 1 - Material Product & Specification Procedure**

## 1.5 Definitions

1.5.1 **Building Regulations:** Where reference is made to “Building Regulations” this shall mean:

Country	Reference
England and Wales	<p>The Building Regulations</p> <p>Approved Documents and Technical Guidance:</p> <p>Part A: Structure</p> <p>Part B: Fire safety. Volume 2: Buildings other than dwelling houses</p> <p>Part C: Site preparation and resistance to contaminants and moisture</p> <p>Part D: Toxic Substances</p> <p>Part E: Resistance to the passage of sound</p> <p>Part F: Ventilation</p> <p>Part G: Sanitation, Hot Water Safety and Water Efficiency</p> <p>Part H: Drainage and Waste Disposal</p> <p>Part J: Combustion appliances and Fuel Storage systems</p> <p>Part K: Protection from falling, collision and impact</p> <p>Part L: L2A - Conservation of fuel and power (New buildings other than dwellings)</p> <p>Part L: L2B - Conservation of fuel and power (Existing buildings other than dwellings)</p> <p>Part M: Access to and Use of Buildings</p> <p>Part N: Glazing (withdrawn)</p> <p>Part P: Electrical Safety</p> <p>Part R: Physical infrastructure for high speed electronic communications networks</p> <p>Regulation 7: Materials and workmanship</p>
Scotland	<p>Building (Scotland) Act. Non-domestic technical handbooks:</p> <p>Section 0: General</p> <p>Section 1: Structure</p> <p>Section 2: Fire</p> <p>Section 3: Environment</p> <p>Section 4: Safety</p> <p>Section 5: Noise</p> <p>Section 6: Energy</p> <p>Section 7: Sustainability</p>

1.5.2 The Construction (Design and Management) (CDM) Regulations 2015 will apply to most projects. The majority of people working on a construction project will have legal duties which are defined under CDM 2015.

1.5.3 Duty holders are defined as follows:

- i. **Client** - Anyone who has construction work carried out for them. The main duty for clients is to make sure their project is suitably managed, ensuring the health and safety of all who might be affected by the work, including members of the public. CDM 2015 recognises two types of client (Commercial and Domestic).
- ii. **Designer** - An organisation or individual whose work involves preparing or modifying designs, drawings, specifications, bills of quantity or design calculations. Designers can be architects, consulting engineers and quantity surveyors, or anyone who specifies and alters designs as part of their work. They can also include tradespeople if they carry out design work. The designer's main duty is to eliminate, reduce or control foreseeable risks that may arise during construction work, or in the use and maintenance of the building once built. Designers work under the control of a principal designer on projects with more than one contractor.
- iii. **Principal Designer** - A designer appointed by the client to control the pre-construction phase on projects with more than one contractor. The principal designer's main duty is to plan, manage, monitor and coordinate health and safety during this phase, when most design work is carried out.
- iv. **Principal Contractor** - A contractor appointed by the client to manage the construction phase on projects with more than one contractor. The principal contractor's main duty is to plan, manage, monitor and coordinate health and safety during this phase, when all construction work takes place.
- v. **Contractor** - An individual or business in charge of carrying out construction work (e.g. building, altering, maintaining or demolishing). Anyone who manages this work or directly employs or engages construction workers is a contractor. Their main duty is to plan, manage and monitor the work under their control in a way that ensures the health and safety of anyone it might affect (including members of the public). Contractors work under the control of the principal contractor on projects with more than one contractor.
- vi. **Worker** - An individual who actually carries out the work involved in building, altering, maintaining or demolishing buildings or structures. Workers include: plumbers, electricians, scaffolders, painters, decorators, steel erectors and labourers, as well as supervisors like foremen and chargehands. Their duties include cooperating with their employer and other duty holders, reporting anything they see that might endanger the health and safety of themselves or others. Workers must be consulted on matters affecting their health, safety and welfare.

1.5.4 Guidance on how to manage and fulfil the duties of each duty holder can be found in the CDM Regulations 2015.

1.5.5 Notwithstanding the above a number of further definitions are made by The Company:

- i. **Contractor:** The person or organisation who undertakes installation, inspection, testing and commissioning activities as well as purchasing of materials and services to undertake these activities.
- ii. **Design:** The set of drawings, calculations and associated documentation required to achieve the objectives of the Design Brief (a descriptive statement which outlines the project-preferred solution).
- iii. **Designer:** The person or organisation who undertakes the design of the project. This shall also include design undertaken by the Contractor.
- iv. **Design Check:** The check undertaken by an independent Engineer within the Design Organisation which produces the design, to ensure that the Design is in

compliance with legislation, design codes, standards and The Company's requirements, and that is suitable for Approval.

- v. **Design Approval:** The phase related to the approval of the 'checked' design, which is undertaken by a Design Approver who ensures that the Design is developed and is consistent with the Users design brief, legislation, standards and all aspects of the contract. For minor works as defined by the User, the Design Approver may undertake the Design Check.
- vi. **Design Output Package (DOP):** The set of 'checked' and 'approved' documents required for the specification and construction of the asset. DOP includes the design specifications, drawings, calculations and associated documentation.
- vii. **Design Appraisal:** A review of the set of 'checked' and 'approved' documents (DOP), which is undertaken by a Design Appraiser who reviews the DOP within his discipline to ensure that the Design meets the required standards, and that all of the documentation required for the project is complete. Any discrepancy with legislation, the design codes or standards identified by a Design Appraiser, which cannot be resolved by the Design Approver, becomes a Deviation. The Appraiser shall not resolve such Deviations but shall refer them back to the Project Manager for resolution.
- viii. **Deviation:** A one off change from the requirements of an Engineering Standard. The original requirements of the standard shall be adhered to until a deviation is approved. Deviations shall be managed in accordance with clause 1.1.2.
- ix. **Project Manager:** The manager appointed by The Company having responsibility for the management of the Project.

1.5.6 Definitions for other Responsible Persons, Process, Outputs and Disciplines shall be in accordance with GD/PM/G/17: "Management procedure for the management of new works, modifications and repairs".

1.5.7 Environment Agencies: Where reference is made to "Environment Agencies" this shall mean:

Country	Reference
England	Environment Agency
Scotland	Scottish Environment Protection Agency
Wales	Natural Resources Wales

## 1.6 Drawings

1.6.1 Drawings produced for the project shall be prepared in accordance with GD/SP/RE/3: "Management Procedure for Engineering Drawing Records".

## 1.7 As built drawings and documents

1.7.1 The Contractor shall provide on completion of siteworks all as-built drawings and other documents including delivery notes, material certificates, manufacturing, operating and maintenance instructions, if relevant, covering the components of the completed construction, and shall identify all changes from the construction issue drawings and documents.

## 1.8 Personnel undertaking design, construction and testing

1.8.1 Personnel undertaking or supervising designs, investigations, construction and testing shall be competent, experienced and qualified in the specific area of works.

- 1.8.2 An appropriate competent geotechnical advisor or geotechnical specialist shall be employed in the planning, procurement, supervision and interpretation of site / ground investigation work. The person should be associated with the geotechnical aspects from conception to construction completion.

## 1.9 Design life

- 1.9.1 The minimum design life expectancies of all permanent geotechnical works (including foundations, retaining walls, substructures, buried structures, culverts, earthworks, reinforced earth walls, abutments, wing walls, ground anchorages) shall be equal to 100 years. For the minimum design life of other assets the Designer shall refer to The Company specification GD/SP/CE/1.

## 1.10 Design and Construction

- 1.10.1 The Designer and / or Contractor shall comply with the procedure described in GD/PM/G/17: "Management procedure for the management of new works, modifications and repairs" and with the requirements of the Construction (Design and Management) Regulations (CDM Regulations) with due consideration given to full life cycle of project.
- 1.10.2 Any changes to the specifications, designs or drawings proposed or due to changes to the basis of the design shall be immediately brought to the attention of the Designer. The Designer shall consider such changes and recommend acceptance, modification, or rejection of the design change process in accordance to the procedure described in GD/PM/G/17.
- 1.10.3 The investigation, design and construction of the works shall take due cognizance of the geo-environment, other infrastructure and watercourses and include due allowance for the effects of the geo-environment, climate and time upon the ground and the resultant interaction of the assets with the ground to enable the integrity, durability and performance of the works to meet the above requirements. The respective investigation, design and construction method statement submissions shall contain all relevant details necessary to demonstrate that the above requirements shall be met, including any details of monitoring and action trigger levels and subsequent actions proposed to ensure that the execution of the work complies with the design analysis or that departures from such design predictions remain tolerable.
- 1.10.4 Temporary works required during construction, modification or maintenance of the works shall be managed in accordance with GD/PM/SHES/10103 'Control of Temporary Works Standard', which defines the roles and responsibilities of the different people and organisations involved, as well as the key appointments which shall be made and key procedures which shall be followed. Other relevant specifications should also be reviewed, including but not limited to; CDM 2015, GD/SP/SSW/22 and HSG/47.

## 1.11 Requirements of third parties

- 1.11.1 The requirements of third parties such as Statutory Authorities, owner(s), landowner(s) or occupier(s), who control assets which are affected by the proposed works, shall, if practicable, be taken into account. Where such requirements are incompatible with the requirements of the relevant design and neither can be modified to suit, details of third party's requirements and the conflicts with the relevant design specification shall be referred to the Project Manager. Such notification shall be undertaken at the earliest practical opportunity.
- 1.11.2 The Designer shall establish the requirement of the owner / operator for acceptance criteria for the integrity, durability and performance of any affected third party asset(s) or the acceptable levels of impact upon the geo-environment such that the design and construction accords with the third party owner / operator's requirements unless otherwise agreed.

- 1.11.3 Works affecting third party land shall minimise disturbance to it with restoration to at least the pre-existing conditions in an approved manner.

## 1.12 Approval of structures in public highways

- 1.12.1 The Designer and Contractor of any structures in public highways, as defined in “Design Manual for Roads and Bridges, Volume 1, Section 1, Part 1: Technical Approval of Highway Structures”, shall be responsible for complying with the requirements of that document and any other relevant highway authority requirements.

## 1.13 Environment and sustainability

- 1.13.1 The design and construction of all permanent and temporary works shall comply with The Company’s environmental and sustainability policies. Notwithstanding this, the construction works shall be carried out to minimise waste and maximise recycling of suitable materials.

## 1.14 Geotechnical Categories

- 1.14.1 In order to establish geotechnical design requirements, the three Geotechnical Categories (1, 2 and 3) of BS EN 1997 “Geotechnical Design”, Part 1 ‘General Rules’ shall be used.
- i. **Category 1** - includes only small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations and where there is negligible risk of failure.
  - ii. **Category 2** - includes conventional types of structures and foundations where there is no exceptional risk of failure or difficult ground or loading conditions.
  - iii. **Category 3** - normally includes structures or parts of structures which fall outside the limits of Geotechnical Categories 1 and 2.
- 1.14.2 The Geotechnical Category shall be preliminarily classified prior to the geotechnical investigations and checked and changed as necessary at each stage of the design and construction process.

## 2 SITE ASSESSMENT AND INVESTIGATIONS

### 2.1 References

2.1.1 The Designer should utilise, where appropriate, the latest editions current at the date of Tender issue of the following references unless otherwise stated in the Contract:

	Activity	Reference
1a	Ground investigations and reporting	BS EN 1997: 'Geotechnical design' and UK National Annexes Part 1: General rules Part 2: Ground investigation and testing
1b		BS EN ISO 22475 Geotechnical investigation and testing – Sampling methods and groundwater measurements Part 1: technical principles for execution
1c		BS EN ISO 22476: Geotechnical investigation and testing - Field testing Part 1: Electrical cone and piezocone penetration test Part 2: Dynamic probing Part 3: Standard penetration test Part 12: Mechanical cone penetration test (CPTM)
1d		BS 22475: 'Geotechnical investigation and testing. Sampling methods and groundwater measurements'. Part 2: Qualification criteria for enterprises and personnel (see Note 1) Part 3: Conformity assessment of enterprises and personnel by third party (see Note 1)
1e		BS 5930:2015: Code of Practice for site investigations. (see Note 1)
1f		BS 1377: Methods of test for soils for civil engineering purposes: Part 1: General requirements and sample preparation Part 2: Classification tests Part 3: Chemical and electro-chemical tests Part 4: Compaction related tests Part 5: Compressibility, permeability and durability tests Part 6: Consolidation and permeability tests in hydraulic cells and with pore pressure measurement Part 7: Shear strength tests (total stress) Part 8: Shear strength tests (effective stress) Part 9: In-situ tests (partially replaced by BS EN 1997-2 and BS EN ISO 22476, Parts 2 and 3)



	<b>Activity</b>	<b>Reference</b>
1g		UK Specification for Ground Investigation Second edition 2012 published by ICE Publishing.
1h		BS 10175:2011+A2:2017: Investigation of potentially contaminated sites. Code of Practice (see Note 1)
1i		BS ISO 5667-11: Water quality. Sampling. Guidance on sampling of groundwaters.
1j		Environment Agency R&D Technical Report P5-065/TR: Technical aspects of site investigation
1k		AGS4: "Electronic transfer of geotechnical data" published by The Association of Geotechnical and Geoenvironmental Specialists (AGS) (see Note 1)
2	Geoenvironmental and geotechnical investigations	AGS Guidelines for Good Practise in Site Investigations and AGS Guidelines for Good Practice in Geotechnical Ground Investigation, published by Association of Geotechnical and Geoenvironmental Specialists (AGS) (see Note 1)
3	Measurement and monitoring of contamination levels	"Performance standard for laboratories undertaking chemical testing of soil" published by Environment Agency (see Note 1)
4	Testing of soils and ground water adjacent to concrete	BRE Special Digest 1: Concrete in aggressive ground
5a	Identification and classification of soils and rocks	BS EN ISO 14688: Geotechnical investigation and testing — Identification and classification of soil Part 1: Identification and description Part 2: Principles for a classification
5b		BS EN ISO 14689: Geotechnical investigation and testing — Identification and classification of rock Part 1: Identification and description
6a	Investigation requirements for stages of the project	GD/SP/TR/21: Specification for feasibility studies of pipelines and installations operating at above 7 barg
6b		GD/SP/TR/22: Specification for environmental statement for pipelines and installations operating at above 7 barg
6c		GD/SP/TR/23: Specification for conceptual studies of pipelines and installations operating at above 7 barg
6d		GD/SP/TR/18: Specification for the engineering of pipelines and installations operating at above 7 barg

	<b>Activity</b>	<b>Reference</b>
<b>7</b>	Investigations for works crossing Network Rail land	GD/SP/G/27: Specification for installing NGG gas pipes adjacent to and across Network Rail tracks
<b>8a</b>	Investigations and testing required for ground anchors	BS EN 1537: Execution of special geotechnical works ground anchors
<b>8b</b>		BS 8081: Code of Practice for grouted anchors
<b>9a</b>	Testing required for strengthened / reinforced soils	BS 8006: Part 1: Code of Practice for strengthened / reinforced soils and other fills Part 2: Code of Practice for strengthened / reinforced soils. Soil nail design
<b>9b</b>		BS EN 14490:2010: "Execution of special geotechnical works – Soil nailing"
<b>10</b>	Retaining Structures	BS 8002:2015: Code of Practice for earth retaining structures
<b>11</b>	Foundations	BS 8004:2015: Code of Practice for foundations

Note 1: The documents in the list above marked (see Note 1) contain some useful information for the design that is complementary to Eurocode requirements. However there might be some information that is contradictory or inconsistent with the Eurocodes for example references to withdrawn standards. It shall be the responsibility of the Designer to extract only the technical information aligned to the Eurocodes' principles and requirements.

## **2.2 General**

- 2.2.1** The requirements of the Construction (Design and Management) Regulations (CDM Regulations) should be given due consideration in relation to the planning of any Geotechnical investigations and designs, to ensure that the right information regarding risks is collected, communicated effectively and managed appropriately.
- 2.2.2** Risks to the environment by the proposed works and by the environment on the proposed works shall be identified and investigated such that they can, in order of preference, be avoided, mitigated or controlled by design and/or by particular precautions during construction.
- 2.2.3** The risks to integrity, durability, construction, operation and maintenance of the proposed works from seismic, liquefaction and/or other geo-environment hazards shall be investigated.
- 2.2.4** The type of equipment for ground investigations shall be selected based upon access restrictions and to avoid, or at least minimise, damage to the ground within the access routes and working areas.
- 2.2.5** The Designer shall consult the Contractor, if appointed, regarding their ground investigation requirements to enable the design of temporary works.

## 2.3 Testing and measurements

2.3.1 Measurement and / or monitoring of contamination levels shall be in accordance with the requirements of the environment agencies Monitoring Certification Scheme (MCertS) or similar scheme.

2.3.2 Laboratory tests shall be carried out by laboratories accredited to BS EN ISO/IEC 17025: "General requirements for the competence of testing and calibration laboratories" and by UKAS (United Kingdom Accreditation Service) for the particular type of test concerned. Test equipment, whether field or laboratory equipment, shall be within calibration and the Contractor shall provide copies of certificates of calibration.

## 2.4 Exclusion of ground investigations for minor works

2.4.1 Subject to the Project Manager's approval and provided they fall in Geotechnical Category 1, minor works constructed to The Company standard drawings, may be constructed without the completion of physical ground investigations in advance of the site work provided that the ground does not comprise unacceptable materials as defined in "Specification for Highway Works, Series 600: Earthworks". If observation method is to be used, suitable competence / experience must be demonstrated by the person responsible.

## 2.5 Planning of ground investigations

### 2.5.1 Objectives:

2.5.1.1 Geotechnical investigations shall be planned in such a way as to ensure that relevant geotechnical information and data are available at the various stages of a project. Geotechnical information shall be adequate to manage identified and anticipated project risks.

2.5.1.2 Before designing the investigation programme, the available information and documents shall be evaluated in a desk study.

2.5.1.3 Geotechnical investigations should consist of ground investigations and other investigations for the site, such as appraisal of existing constructions, the history of development on and around the site.

2.5.1.4 The aims of a geotechnical investigation are to establish the soil, rock and groundwater conditions, to determine the properties of the soil and rock, and to gather additional relevant knowledge about the site.

2.5.1.5 Careful collection, recording and interpretation of geotechnical information shall be made; this information shall include ground conditions, geology, geomorphology, seismicity and hydrology and hydrology as relevant, including variability of the ground.

2.5.1.6 The Designer shall provide a scope of works specific to the project in relation to:

- i. The requirements for, and the extent any ground investigation(s).
- ii. The nature and extent of appropriate investigations, assessments and / or tests required.

These investigations need to consider the Geotechnical Category and the requirements of BS EN 1997-2 and other associated standards.

### 2.5.2 Desk studies and site inspections:

2.5.2.1 Desk studies shall be carried out at the earliest practical opportunity during the project development for the proposed works unless both the following conditions apply:

- i. Experience of site conditions or information available from previous phases of development of each relevant location are sufficient to fulfil the objectives of a desk study.

- ii. The extent of coverage of such data includes the proposed works' locations both in plan and depth.
- 2.5.2.2 Desk studies shall be followed by site inspections and geomorphological survey.
- 2.5.2.3 Where aerial photography (or other remote sensed data) is used, it shall be assessed by a geomorphologist or engineering geologist or geotechnical engineer.
- 2.5.2.4 The desk study shall include:
- i) Searching for and obtaining available existing data concerning the ground including nature of soils and rock and ground water conditions. Examples of documents that can be used are: topographical, historical, geological and hydrogeological maps, previous investigations at the site and in the surroundings, previous experiences from the area, including available information held by The Company.
  - ii) Interpreting the available data to assess the implications of the terrain and ground conditions for:
    - a) The proposed works.
    - b) The impacts of the proposed works upon the performance, integrity and durability of adjacent infrastructure and the stability of the adjacent ground.
    - c) The impacts of the proposed works upon the geo-environment.
    - d) Identify hazards and issues requiring further investigation / assessment.
  - iii) Interpreting the available data to plan and optimise subsequent ground investigations and project development and to locate the various investigations points representing the variation in ground conditions for soil, rock and groundwater. Particular reference shall be made to potential hazards to the health and safety of ground investigation personnel and the public, as well as reducing technical, safety, environmental, cost and timescale uncertainty for the project.
- 2.5.2.5 Desk studies shall investigate the effects upon the proposed works in relation to:
- i) Known or potential ground instability.
  - ii) Known or potential subsidence or differential ground movement.
  - iii) Ground water levels and flows including variations with time from springs, confined aquifers or other seepages.
  - iv) Areas prone to flooding, including areas prone to flash floods.
  - v) Compressible ground or soils potentially liable to collapse settlement.
  - vi) Areas of clayey soils with significant shrink / swell potential.
  - vii) Rock or hard ground.
  - viii) Obstructions within the ground.
  - ix) Areas of known or potentially contaminated ground including electrical attack (due to high carbon content).
  - x) Areas of potential gaseous emissions from the ground.
  - xi) Areas that may result in chemical attack upon materials to be used in the proposed works (due to the nature of the ground and / or groundwater) or result in expansive reactions upon exposure or weathering of the ground.
  - xii) Areas of known or potentially subject to seismic and / or liquefaction hazards.
  - xiii) Areas of known or potential hazards from geo-environment.
- 2.5.2.6 Desk studies shall include interpretations and assessments to facilitate design, planning and costing of the works in relation to at least the following:
- i) Trafficability of ground during construction.

- ii) Ease of excavation.
- iii) Excavation stability.
- iv) Areas potentially requiring temporary dewatering and / or enhancement of drainage regimes.
- v) Suitability of excavated materials for reuse as fill.
- vi) Ground susceptibility to shrink / swell movements due to seasonal or progressive moisture content change (which may in turn induce differential movement between elements as well as leading to progressive failure of slopes).
- vii) Appropriate levels / techniques for foundations.
- viii) Indicative allowable bearing capacities for foundations and probable foundation movements.
- ix) Suitability of existing ground at sites as subgrade for roads.
- x) Issues relating to reinstatement requirements.

2.5.2.7 The findings from the desk study need to be cross-checked against the information gathered by site inspections including any geomorphological survey. The detail of the final report should reflect the size and nature of the project. A detailed final desk study report shall include:

- i) Executive summary.
- ii) Contents.
- iii) Introduction giving the location and primary purposes of the proposed works and the area of search considered.
- iv) Brief descriptions of each of the various geological strata, both 'superficial' and 'solid' deposits.
- v) Brief descriptions of each of the various soil types (with reference to National Soil Research Institute (NSRI) for England and Wales and / or Macaulay Land Use Institute MLUI) for Scotland as relevant.
- vi) Descriptions of the hydrogeological regimes.
- vii) Potential risks to the integrity of the proposed works and any recommended avoidance, mitigation or control strategies that should be considered during subsequent stages of project development.
- viii) Potential risks to the geo-environment posed by the proposed works and any recommended avoidance, mitigation or control strategies that should be considered during subsequent stages of project development.
- ix) Potential risks posed by the proposed works to adjacent infrastructure and any recommended avoidance, mitigation or control strategies that should be considered during subsequent stages of project development.
- x) Potential risks to the construction of the proposed works.
- xi) Appropriate summaries of potential risk areas including distinguishing between severity ratings, summarised in the following formats:
  - a) Graphically with appropriate maps showing the location and extent of the sites considered together with the areas affected by the various identified hazards.
  - b) In tabular form quantifying the extent to which the sites are affected by the various identified hazards.
- xii) Appendices including:
  - a) Data sources.
  - b) Names of contributing personnel and their qualifications.

- c) Definitions of classification terminology used in the report (including for classes of strength, degree of weathering, wetness, trafficability, ease of excavation, trench stability, risk severity grading descriptions).
- d) Details of soil or rock classification and / or description and engineering characteristics (which would otherwise significantly detract from comprehension of the main text if placed within the body of the report).
- e) Supplementary data, mapping or interpretation intended as evidence for statements in the body of the report but of a particularly specialist nature.
- f) Details of any proposed investigation, such as:
  - a. Objectives.
  - b. Special problems to be investigated.
  - c. Proposed investigation.
  - d. Site and working restrictions.
  - e. Specialist Consultation.
  - f. Programme, cost and contract arrangements.
  - g. Reporting.

### 2.5.3 **Ground investigations:**

- 2.5.3.1 Ground investigations shall be planned based upon the Geotechnical Category, the findings of the desk study and the nature of the proposed project. It should be noted that the general requirements of BS EN 1997-2 and Geotechnical Category should be deemed the minimum requirements and some projects (such as pipeline routes) and / or some geohazards (such as soluble deposits, mine workings, etc.) may require a more robust ground investigation.
- 2.5.3.2 Ground investigations should consist of field investigations, laboratory testing, additional desk studies and controlling and monitoring, where appropriate.
- 2.5.3.3 During the ground investigations, the Designer shall review the findings and the scope of works varied or extended, if considered necessary.
- 2.5.3.4 Ground investigations should include the testing and investigation requirements identified in clauses 2.10 to 2.13, where necessary.
- 2.5.3.5 Requirements for ground investigations and testing of soils are given in BS EN 1997 'Geotechnical design', Part 2 'Ground investigations and testing', which provides the framework for selecting the values of the geotechnical properties.
- 2.5.3.6 For the values of the geotechnical parameters as well as for the methods to carry out the geotechnical investigation and testing of soil, rock and groundwater, the Designer may refer to the relevant parts of BS EN 1997-2 and the related normative references mentioned in the Table in 2.1.1. Some detail containing the evaluation of geotechnical parameters is also given in BS EN 1997-1.
- 2.5.3.7 Requirements of testing of soil and groundwater in contact or adjoining concrete, testing for frost susceptibility, investigations for groundwater control, investigations for machine foundations, and landslide and slope stability, shall be considered in planning the investigations, where relevant.
- 2.5.3.8 Additional requirements as included in the Ground Investigation Report and in the Geotechnical Design Report shall be considered in planning the investigations, where relevant.
- 2.5.3.9 If considered necessary and agreed, sequential stages of investigation shall be undertaken including 'preliminary investigations', 'design investigations' and 'controlling and monitoring' as defined by BS EN 1997 'Geotechnical design', Part 2 'Ground investigations and testing'.

- 2.5.3.10 Each further stage of investigation shall confirm the information (and its interpretation) obtained from the previous stage and provide any desired additional data.
- 2.5.3.11 Sufficient trial pits, trial trenches or boreholes (as appropriate) shall be carried out in order to provide an adequate correlation between the relevant data sets and thus confirm or inform the interpretation of the desk study to an acceptable level of confidence.

## 2.6 Ground Investigation Report (GIR) and Geotechnical Design Report (GDR)

- 2.6.1 The results of geotechnical investigations shall be compiled in the Ground Investigation Report as described in BS EN 1997 'Geotechnical design', Part 2 'Ground investigation and testing'. The Ground Investigation Report shall be included in the Geotechnical Design Report.
- 2.6.2 In the Geotechnical Design Report the Designer shall record the assumptions, data, methods of calculation and results of verification of safety and serviceability as described in BS EN 1997 'Geotechnical design', Part 1 'General rules'.
- 2.6.3 The Ground Investigation Report should be provided within 4-6 weeks of completing the last exploratory hole; depending on the size and nature of the project. The delivery time for the Geotechnical Design Report shall be dependent on the size and nature of the project and complexity of any testing or monitoring requirements. It might be expected that a simple GDR may be issued within 8-10 weeks of completing the last exploratory hole. The delivery time for draft and final copies of these reports shall be agreed with the Designer.
- 2.6.4 The electronic version of the Final Reports shall also comply with "Electronic transfer of geotechnical data from ground investigations" by the Association of Geotechnical and Geoenvironmental Specialists (AGS).
- 2.6.5 In addition to the requirements of the relevant standards BS EN 1997 'Geotechnical design' Part 1 'General rules' and Part 2 'Ground investigation and testing', and the UK Specification for Ground Investigation second edition, daily reports shall include comments on the weather conditions during the execution of the investigations.
- 2.6.6 The Ground Investigation Report shall consist of a presentation of geotechnical information and their evaluation as described in BS EN 1997-2. The Ground Investigation Report shall include ground conditions with respect to:
- i) Degree of correlation with the findings of the Desk Study.
  - ii) General ground stability.
  - iii) Contamination encountered or suspected.
  - iv) Areas requiring additional detailed or specialist investigation or assessment.
  - v) Primary risks to the execution of the proposed works.
  - vi) Derived values of geotechnical parameters and/or coefficients, obtained from test results by theory, correlation or empiricism.

## 2.7 Geotechnical Design Reports – pipeline routes

- 2.7.1 Reports shall be in accordance with the relevant standard BS EN 1997 'Geotechnical design' Part 1 'General rules', and shall include in addition interpretations and assessments of the pipeline routes in relation to at least the following:
- i) Trafficability (following topsoil strip) and requirements for haul routes.
  - ii) Ease of excavation.
  - iii) Stability of excavation, including:
    - a) Potential for collapse of trench walls.

- b) Potential for base heave or piping.
- c) Ground water ingress to excavations and dewatering requirements.
- d) Requirements for excavation support.
- iv) Suitability (in terms of bearing resistance) of trench formation.
- v) Sections likely to be subject to hydraulic failure on the proposed pipeline and any recommendations for mitigation measures.
- vi) Suitability of as-dug material for bedding, surround and backfill materials, including:
  - a) Any specific recommendations or requirements for reinstatement of the land.
  - b) Potential needs for crushing / screening.
  - c) Ability to respond to compaction.
  - d) Potential for chemical attack upon construction materials.
  - e) Corrosivity.
  - f) Stability against erosion following backfilling / replacement.
- vii) Suitability of materials for trenchless pipeline construction techniques at infrastructure crossings (taking into account the intended pipeline depth).
- viii) Recommendations for revisions to pipeline depth and / or trenchless installation technique where conditions are unsuitable at the intended depth.
- ix) Any particular concerns regarding bore stability, boring equipment wear rates and potential for water ingress or lubrication / mud loss for trenchless crossing locations.
- x) Issues relating to reinstatement of the land.
- xi) Existing assets deemed at particular risk from the construction of the proposed works.
- xii) Special crossings.

## 2.8 Geotechnical Design Reports - Installations

### 2.8.1

Reports shall be in accordance with the relevant standard BS EN 1997 'Geotechnical design' Part 1 'General rules', and shall include in addition interpretations and assessments of installations in relation to at least the following:

- i) As per items i) to viii) for Geotechnical Design Reports – pipeline routes, but with reference to foundations, pits and pipework trenches.
- ii) Potential of ground strata for collapse settlement or other geotechnical instability.
- iii) Recommendations as to appropriate type(s) and levels of foundations (for the anticipated loads), including:
  - a) bearing resistance of subsoil at various depths (including details of the derivation of such values).
  - b) anticipated extent and rate of settlement of proposed foundations (including details of the derivation of such values).
- iv) The aggressive chemical environment class (ACEC) of the strata encountered and the resultant impacts upon concrete design (including any need for additional protective measures).
- v) Safe sides slopes for cuttings and embankments including the maximum height of such embankments where necessary (with details of the derivation of such values).
- vi) Options for drainage of the installation.
- vii) Susceptibility of soils to frost heave.



- viii) Suitability of upper subsoils (i.e. material below topsoil) within installation sites as subgrade for road construction (including comment on any measured CBR values and expected equilibrium CBR values).
- ix) Indicative impacts of ground movements due to excavations and / or foundations for the works on existing assets.
- x) Soil-pipe interaction parameter ranges and stress analysis parameters for the stress analysis of buried pipework / structures.

## **2.9 Materials and workmanship**

2.9.1 Materials and workmanship shall be in accordance with “UK Specification for Ground Investigation Second edition” 2012 published by ICE Publishing.

## **2.10 Testing of soils and groundwater in contact or adjoining proposed concrete**

2.10.1 Where samples (from trial pits, trial trenches or boreholes) are taken from soils and / or groundwater likely to be in contact with, or in proximity to, concrete to be placed below ground level as part of the permanent works, tests to determine the aggressive chemical environment class (ACEC) as defined in BRE Special Digest 1: “Concrete in aggressive ground” shall be carried out appropriate to the location of the works.

## **2.11 Testing for frost susceptibility**

2.11.1 Testing of soils for frosts susceptibility shall be undertaken in accordance with “Specification for Highway Works, Series 800: Road pavements unbound cement and other hydraulically bound mixtures”.

## **2.12 Investigations for groundwater control**

2.12.1 Where groundwater control is required, the investigations shall be carried out to determine:

- i) Variation in soil and rock lithology.
- ii) Permeability to a minimum depth of  $1.5 \times$  depth of excavation using variable head tests in standpipes, piezometers or boreholes.
- iii) Groundwater conditions.

## **2.13 Investigations for machine foundations**

2.13.1 Ground investigations for machine foundations shall include:

- i) In-situ geophysical exploration.
- ii) Tests to identify site ground characteristics relevant to dynamic loading including rates of loading, levels of strain and number of cycles of loading.

### **3 DESIGN**

#### **3.1 General**

##### **3.1.1 Deliverables**

**2.5.2** The following clauses are in addition to the requirements of GD/PM/G/17: "Management procedure for the management of new works, modifications and repairs" and with the requirements of the Construction (Design and Management) Regulations (CDM Regulations) with due consideration given to full life cycle of project.

**3.1.1.1** The Designer shall provide the necessary information to satisfy the following requirements:

- i.** Demonstrate that the Designer understands and has met The Company's and third parties' requirements.
- ii.** Allow a Design Approval / Appraisal to be carried out, including confirmation of method of approach; assumptions; derived / adopted parameters including parameters / choices selected for use with the Structural Eurocodes; record of agreed Deviations; confirmation that design has been checked and approved.
- iii.** Drawings and Specifications to allow the Contractor to construct the works, including appropriate material specifications and project-specific requirements.
- iv.** Risks and assumptions concerning the construction works, including assumed construction sequence; any specific requirements for temporary works; residual risks and hazards which have not been eliminated by the design which might not be obvious, are unusual or which might be difficult to manage.
- v.** Risks and assumptions concerning operation, maintenance and future decommissioning of the works, including residual risks and hazards which have not been eliminated by the design. Where relevant, these shall be stated in the Geotechnical Design Report.

**3.1.1.2** The Designer shall demonstrate and prove that the correct, latest European and / or British and / or International and / or Building Industry and / or other Standards and regulations are used on the project by reference in report or calculation sheet.

**3.1.1.3** The design of the works shall include consideration of the potential effects of the design, construction, operation, maintenance and demolition / clearance of an element upon adjacent infrastructure and the geo-environment.

**3.1.1.4** For the design of new structures, structural parts and elements, the Designer shall use the suite of Structural Eurocodes and associated documents. In exceptional situations where it is not possible to carry out the design to Structural Eurocodes and associated documents (for example where the proposed materials are not covered by Eurocodes), the Designer shall seek approval from the Project Manager and Competent Design Authority to use alternative standards.

**3.1.1.5** Where existing structures are to be reused or modified:

- i.** The Designer shall demonstrate that the structure following the modification is capable of safely resisting the design actions.
- ii.** For structures that will be subject to greater actions than they were originally designed for, and structures that have deteriorated, the Designer shall carry out a quantitative analysis of ultimate limit state resistance as part of this assessment, taking into account the in-situ properties and condition of the materials and ground as appropriate.
- iii.** The Structural Eurocodes may be used as basis for the structural appraisal of existing construction, in developing the design of repairs and alterations or in assessing changes of use. For older structures it may not be possible to

demonstrate all of the requirements for new design, particularly relating to detailing, material properties and tolerances. In these cases, additional or amended provisions might be necessary and shall be recorded, approved and appraised.

- 3.1.1.6 Any non-conforming details and associated risks shall be recorded, approved and appraised. If there is any concern regarding the reliability of the existing structure, then the Designer shall propose and design strengthening, or replacement works.
- 3.1.1.7 The design of the works shall include consideration of the potential effects of the design, construction, operation, maintenance and demolition / clearance of an element upon adjacent infrastructure and the geo-environment.
- 3.1.1.8 The structural Eurocodes require certain parameters / approaches / choices to be specified or determined on a project-specific basis. The Designer shall ensure that appropriate Eurocode parameters are selected for applicable clauses where choice is permitted by the Eurocodes. Specific requirements of The Company and guidance are given in Appendix A of GD/SP/CE/1.
- 3.1.1.9 Calculations with any back up information shall be supplied for any elements requiring sizing or having operation, maintenance and / or health and safety effects in such detail to enable an independent person to fully understand the logic and be able to check the correctness of the information in the future.
- 3.1.1.10 All design work shall be undertaken, checked and reviewed by competent, experienced engineers as appropriate for the relevant aspect of work. Furthermore, such engineers shall consider and utilise all reasonable design methods to suit specific situations irrespective of this Specification.

### 3.1.2 **Investigations**

- 3.1.2.1 The Designer shall request / undertake any site work necessary to ensure that elements are designed and constructed to interconnect with each other and suit previously placed items. Any risks associated with absence of information regarding previously placed items shall be recorded, approved and appraised.

### 3.1.3 **References**

- 3.1.3.1 If the Designer considers that an alternative reference to that specified in this document is more applicable, the approval of the Project Manager and Competent Design Authority shall be obtained prior to commencement of the design through the Deviation Process.

### 3.1.4 **Management of structural reliability**

- 3.1.4.1 For the management of the structural reliability of The Company works:
  - i. Structural reliability of structural works shall be managed in accordance with the requirements of GD/SP/CE/1.
  - ii. Structural reliability of works involving geotechnical actions shall be managed by application of the Geotechnical Categories of BS EN 1997 "Geotechnical Design", Part 1 'General Rules' in accordance with Section 1.14 of GD/SP/CE/2.

## 3.2 References

3.2.1 The Designer shall comply, as applicable, with all relevant technical publications produced by The Company.

3.2.2 Notwithstanding the above, the Designer should also utilise, where appropriate, the latest editions current at the date of Tender issue of the following references unless otherwise stated in the Contract:

	Activity	Reference
1a	Design – general	BS EN 1990: 'Basis of structural design' and UK National Annex to BS EN 1990
1b		BS EN 1997: Eurocode 7 and UK National Annex: Geotechnical design Part 1: General rules Part 2: Ground Investigation and testing
2a	Buried gas pipelines and associated structures	IGEM/TD/1: Steel pipelines for high pressure gas transmission
2b		IGEM/TD/3: Steel and PE pipelines for gas distribution
2c		IGE/TD/12: Pipe-work stress analysis for gas industry plant
2d		IGEM/TD/13: Pressure regulating installations for transmission and distribution
3	Crossings in public highways	"Specification for the reinstatement of openings in highways" published by Highway Authorities and Utilities Committee (HAUC)
4a	Slope stability analysis	BS EN 1997: Eurocode 7 and UK National Annex: Geotechnical design
4b		BS 6031: Code of Practice for earthworks
5a	Foundations – general and piling	Building Regulations:
		Building Regulations: Technical Guidance Document A - Structure
		Building Regulations non-domestic Technical Handbook Section 1 - General
		DOE Technical booklet D - Structure
5b		BS EN 1997: Eurocode 7 and UK National Annex: Geotechnical design Part 1: General rules Part 2: Ground investigation and testing

	Activity	Reference
5c		BS 8004:2015: Code of Practice for foundations
5d		BS EN 1992: Design of concrete structures. Part 3: 'Liquid retaining and containment structures'
5e		BS 8102: Code of Practice for protection of below ground structures against water from the ground (see Note 1)
5f		BS 8102: Code of Practice for protection of structures against water from the ground
5g		BS EN 1993 Eurocode 3: Design of steel structures and UK National Annex
6a	Ground anchors	BS EN 1537: Execution of special geotechnical works - Ground anchors
6b		BS 8081: Ground anchorages (where not replaced)
7	Machine foundations	CP 2012: Foundations for machinery Part 1: Foundations for reciprocating machines (see Note 1)
8a	Noise and vibration	BS 5288: Code of practice for noise and vibration control on construction sites
8b		BS 7385: Evaluation and measurement of vibration in buildings Part 2: Guide to damage levels from groundborne vibration
8c		BS ISO 4866: 'Mechanical vibration and shock. Vibration of fixed structures. Guidelines for the measurement of vibrations and evaluation of their effects on structures'
9	Bridge foundations	BS EN 1992: Design of concrete structures Part 2: 'Concrete bridges - Design and detailing rules' and UK National Annex to BS EN 1992-2
10	Light column foundations	BS EN 40: Lighting columns Part 2: General requirements and dimensions
11	Groundwater control in excavations	CIRIA Report C515: Groundwater control – Design and practice (see Note 1)
12a	Earth retaining structures	BS EN 1997: Eurocode 7 and UK National Annex: Geotechnical design
12b		BS 8002: 2015: Code of Practice for earth retaining structures

	Activity	Reference
12c		ICE Specification for piling and embedded retaining walls
13a	Earthworks in general as well as embankments and cuttings	BS EN 1997 Eurocode 7 and UK National Annex: Geotechnical design Part 1: General rules
13b		BS 6031: Code of Practice for earthworks
13c		Manual of Highway Contract Documents, Design manual for roads and bridges Volumes 1 & 2 (see Note 2)
13d		Specification for Highway Works Series 600: Earthworks. (see Note 2)
13e		BS 8006 Part 1: Code of practice for strengthened / reinforced soils and other fills Part 2: Code of practice for strengthened / reinforced soils. Soil nail design
13f		BS EN 14475: Execution of special geotechnical works - Reinforced fill
13g		BS EN 14490: Execution of special geotechnical works. Soil nailing.
14a	Embankments	IGE/TD/12: Pipe-work stress analysis for gas industry plant
14b		IGEM/TD/13: Pressure regulating installations for transmission and distribution
15	Mine workings	CIRIA C758: Abandoned mine workings (in publication)
16	Quarry Operations	HSE: Health and safety at quarries: Quarries Regulations 1999; Approved Code of Practice and guidance GD/SP/GM/10: Management Procedure for Quarries, other large excavations or similar activities in close proximity to Gas Pipelines and Associated Installations

	Activity	Reference
17a	Actions	<p>BS EN 1991: Actions on structures</p> <p>Part 1-1: 'General actions – Densities, self- weight, imposed loads for buildings' and UK National Annex to BS EN 1991-1-1</p> <p>Part 1-2: 'General actions – Actions on structures exposed to fire' and UK National Annex to BS EN 1991-1-2</p> <p>Part 1-3: 'General actions – Snow loads' and UK National Annex to BS EN 1991-1-3</p> <p>Part 1-4: 'General actions – Wind actions' and UK National Annex to BS EN 1991-1-4</p> <p>Part 1-5: 'General actions – Thermal actions' and UK National Annex to BS EN 1991-1-5</p> <p>Part 1-6: 'General actions – Actions during execution' and UK National Annex to BS EN 1991-1-6</p> <p>Part 1-7: 'General actions - Accidental actions' and UK National Annex to BS EN 1991-1-7</p> <p>Part 2: 'Traffic loads on bridges' and UK National Annex to BS EN 1991-2</p> <p>Part 3: 'Actions induced by cranes and machines' and UK National Annex to BS EN 1991-3</p> <p>Part 4: 'Silos and tanks' and UK National Annex to BS EN 1991-4</p>
17b		<p>PD 6688</p> <p>Part 1-1: Recommendations for the design of structures to BS EN 1991-1-1</p> <p>Part 1-2: Background paper to the UK National Annex to BS EN 1991-1-2</p> <p>Part 1-4: 'Background information to the National Annex to BS EN 1991-1-4 and additional guidance'</p> <p>Part 1-7: 'Recommendations for the design of structures to BS EN 1991-1-7'</p> <p>Part 2: Background to the National Annex to BS EN 1991-2. Traffic loads on bridges</p>

Note 1:

The documents in the list above marked (see Note 1) contain some useful information for the design that is complementary to Eurocode requirements. However, there might be some information that is contradictory or inconsistent with the Eurocodes for example references to withdrawn standards. It shall be the responsibility of the Designer to extract only the technical information aligned to the Eurocodes' principles and requirements.

Note 2:

The documents in the list above marked (see Note 2) are being updated to be aligned to the Eurocodes and related European test, product and execution Standards. It shall be the responsibility of the Designer to extract only the technical information aligned to the Eurocodes' principles and requirements.

### 3.3 Geotechnical design: general requirements

3.3.1 The Designer shall review and assess the adequacy and credibility of all desk study information and, where applicable, all information contained in the Ground Investigation Report and the Geotechnical Design Report.

3.3.2 The Designer shall review existing GM suite documents to understand particular hazards to pipelines and potential mitigation:

GD/SP/GM/1	Specification for the Protection of Pipelines from Ground Movement and External Loading. External Loading on Steel Pipelines and Buried Piping at Installations
GD/SP/GM/4	Specification for the protection of steel pipelines operating at pressures above 7 bar subjected to vibrations caused by blasting, piling or demolition
GD/SP/GM/8	Specification for Monitoring and Measurement of the Effects of External Loads on Pipelines

3.3.3 Geotechnical design shall be in accordance with BS EN 1997 and other relevant parts of the Structural Eurocodes including the basic requirements of BS EN 1990 and the actions from BS EN 1991.

In particular the design shall take account of:

- i) The geo-environmental and climatic conditions in which the works are to be placed and the hazards that arise.
- ii) The proximity of other sources of actions and their combinations or other relevant effects and their magnitudes (including any variation with time) with respect to how they could influence the proposed asset.
- iii) The serviceability and structural integrity effects of the proposed works on adjoining existing land and assets.
- iv) The ground level variations (both existing and proposed as part of the works) within the vicinity (and the consequential effects on vertical and lateral stresses in the ground).
- v) The response of the ground to the actions and their combinations induced by the works.
- vi) The effects of the construction process and the subsequent presence of the works upon the behaviour of the ground.
- vii) The effects of time and climate upon the characteristics and behaviour of the ground and the materials used in the works.

3.3.4 The design shall endeavour to maximise the utilisation of in-situ materials within the constraints of safety, environmental protection, asset integrity, durability and performance and cost-effectiveness over the whole life cycle of the works. The design should include foundations and their settlement and heave upon loading, permanent and temporary stability condition, groundwater regime, earthworks and earth retaining structures.

### 3.4 Geotechnical parameters

3.4.1 The design shall be based upon geotechnical parameters which have been obtained from test results, either directly or through correlation, theory or empiricism, and from other relevant data as prescribed by the relevant references given within this Specification and according to the Geotechnical Category.

3.4.2 Where the available data for the selection of geotechnical parameters are insufficient to



allow parameter selection, further supplementary ground investigations shall be procured.

3.4.3 The design shall be compatible with construction techniques and sequence.

### **3.5 Buried pipelines and associated structures**

3.5.1 The design of buried gas pipelines and buried gas pipework shall be based upon the location, specified design life, intended design and operating pressures and temperatures as well as the intended testing / commissioning procedures.

3.5.2 As far as possible pipelines should avoid being located under foundations or pavements.

3.5.3 The design shall include for erosion or flow barriers along the pipe trench to prevent:

- i) Travel of contaminated waters, contaminated soil fines and / or hazardous gases.
- ii) Excessive fines loss.
- iii) Adverse effects to drainage and / or ponding of water

### **3.6 Bedding, sidefill and initial backfill to high pressure gas pipelines**

3.6.1 Bedding, sidefill and initial backfill to high pressure gas pipelines shall comply with IGEM/TD/1: "Steel pipelines for high pressure gas transmission".

### **3.7 Unstable land and other geohazards**

3.7.1 Pipeline routing and / or installation site selection should generally endeavour to avoid areas of known or potentially unstable land and other forms of geohazard or ground movement.

3.7.2 Pipelines and associated structures shall be able to withstand environmental actions as identified in GD/PM/IGEM/TD/1 and IGEM/TD/1: "Steel pipelines and associated installations for high pressure gas transmission".

### **3.8 Landslide and slope stability**

3.8.1 In addition to the requirements of BS EN 1997-1 and BS 6031 the stability analysis of earthwork structures shall be undertaken using the more onerous of effective stress or total stress for any combination of external forces or actions for both circular and wedge failure mechanism to locate the critical failure plane. The design shall take account of the following events and actions:

- i) Highest credible phreatic surface and any perched water tables for both the short-term (total stress) condition and the long-term (effective stress) condition.
- ii) Temporary and permanent surcharge loading on the crest and on the slope.
- iii) Excavation in the vicinity of the toe of the slope to formation level and / or for service trenches and drainage.
- iv) Blasting vibrations.

3.8.2 Stability analysis shall be carried out where groundwater may have an adverse effect upon slopes and embankments for temporary and permanent works with mitigation measures specified if required.

### **3.9 Frost heave**

3.9.1 For the preliminary assessment, materials with the following characteristics shall be considered potentially frost susceptible:

- i) Silts.
- ii) Well drained cohesive material with a plasticity index < 15%.

- iii) Poorly drained cohesive material with a plasticity material < 20%.
- iv) Material < 10% by mass passing a 75 micron sieve.
- v) Chalk (particularly soft or crushed).
- vi) Oolitic or magnesian limestone with an average saturation water content > 3%.
- vii) Burnt colliery discard.
- viii) Crushed or trafficked Sherwood Sandstone.

3.9.2 An assessment of frost heave vertically and horizontally for foundations shall be carried out where buried gas pipework or other plant or method of construction may induce freezing of the ground near foundations.

### 3.10 Collapse settlement

3.10.1 The design of the works shall assess the potential for the ground to undergo collapse settlement (also referred to as collapse compression), differential settlement, creep and inundation. Where such hazards cannot practicably be avoided or mitigated, the design shall include for the potential settlement.

### 3.11 Groundwater control

3.11.1 The effect of methods of groundwater control shall be determined.

### 3.12 Hydraulic failure

3.12.1 Hydraulic failure ultimate limit state calculations, either uplift or heave, depending on the nature of the materials, shall be undertaken if construction is anticipated to be submerged by floods with a return period exceeding 1000 years or to be below the peak ground water level.

3.12.2 Hydraulic failure ultimate limit state calculations, either uplift or heave, shall be undertaken with the more onerous of the ground water level at finished ground level or a flood with a return period of 1000 years.

3.12.3 The permanent action of the fill cover shall be calculated with the ground water levels at the higher of the final ground surface or maximum predicted flood level during the design life of the asset. The weight of backfill in the calculations shall exclude topsoil. The permanent action from other backfill materials shall only be used in the calculations if the risk of their removal by the actions of personnel or nature is negligible.

3.12.4 The partial factors to be used in the ultimate limit state for hydraulic failure calculations shall be in accordance with the National Annex to BS EN 1997-1.

3.12.5 The hydraulic failure of pipelines shall consider the stress or strain conditions arising at 'transition' zones between affected and unaffected sections. Design situations where there is no seepage of water shall be analysed for the UPL (ultimate limit state). Design situations where there is seepage due to hydraulic gradients shall be analysed for the HYD (ultimate limit state). Guidance on submerged structures and how to consider water pressure acting on the top of structure and the base of the structure is presented in Designer's Guide to EN 1997-1. When calculating the stabilising action, the weight of the ground water level should be calculated using the effective weight density  $\gamma'$  of the soil.

3.12.6 The means of counteracting hydraulic failure shall not cause unacceptable longitudinal or circumferential stress or strain within the pipe, damage the pipe coatings or reduce the corrosion protection system performance.

### **3.13 Ground containing gas formation or emissions**

- 3.13.1 Mitigation measures shall be designed where ground contains gas formation and / or emissions.
- 3.13.2 The design shall make allowance for potentially inferior nature of any adjacent ground located above the formation level of the foundation and the possibility of ground adjacent to the foundation being excavated after construction and during the required design life of the works.

### **3.14 Machine foundations**

- 3.14.1 The design shall incorporate the requirements of the manufacturer for satisfactory operation of the machine.
- 3.14.2 The design shall include the effects of the start-up, run-down and range of design operating conditions for the machinery, potential machine out-of-balance forces, moments and vibrations as well as effects during emergency conditions.
- 3.14.3 The foundations design shall control the transmission of vibration(s) such that connected and / or adjacent infrastructure (including services) is not adversely affected, and persons are not subject to unacceptable levels of vibration or noise.

### **3.15 Installation of pipelines by trenchless methods**

- 3.15.1 The distribution of loads and stresses arising from the installation method and any redistribution of such loads and stresses likely to arise within the design life for gas pipelines or sleeves installed by trenchless methods under other infrastructure shall be determined.

### **3.16 Piling for foundations**

- 3.16.1 The selection of pile type and installation technique shall take account of the requirements of GD/SP/GM/4: "Specification for the protection of steel pipelines operating at pressures above 7 bar subjected to vibrations caused by blasting, piling or demolition" where piling is required in proximity to existing gas pipework constructed in steel.

### **3.17 Earthworks**

- 3.17.1 The design of the earthworks shall take account of the geometric profile, drainage, ground movement and volumetric stability during construction and through the design life of the earthworks considering both ultimate limit state and serviceability conditions.
- 3.17.2 Geotechnical design shall be in accordance with BS EN 1997 and BS 6031.

### **3.18 Embankments**

- 3.18.1 The Designer shall determine the required characteristics of the fill(s) to suit the post placement performance requirements.
- 3.18.2 The Designer shall state the limiting criteria for applied actions and combination of actions (including the magnitudes and distribution of loads), and minimum requirements for the capacity of the ground to adequately support the relevant asset(s).

### **3.19 Cuttings**

- 3.19.1 The design of cuttings shall be based upon the more onerous of the temporary or permanent conditions.

## **4 MATERIALS**

### **4.1 Materials**

4.1.1 The Contractor shall be responsible for the proper security, handling and correct storage of all materials.

4.1.2 All materials shall be subject to a stores documentation procedure drawn up to afford security for the materials, provide permanent records of all receipts and issues and arrangements for the disposal of any materials, received by the Contractor and not incorporated in the works.

4.1.3 Certificates of conformity for proprietary products used and material test certificates shall be supplied to demonstrate compliance with the Contract.

4.1.4 Any imported materials for the works procured by the Contractor, which fail to meet the requirements of the contract specification upon delivery to site, shall be removed from site and compliant supplies obtained.

### **4.2 Temporary use of materials**

4.2.1 Materials intended for permanent use in the works shall not be used for temporary purposes during construction except with the approval of the Project Manager.

### **4.3 Material specifications**

4.3.1 Materials specified in this document are minimum requirements at the time of publication of this document. Particular requirements may be stated elsewhere in the design documents. Where any materials proposed by the design are required to comply with a particular standard or specification, the Contractor shall supply all relevant test certificates or compliance documentation.

### **4.4 Material handling**

4.4.1 In addition to the requirements of this Specification, materials shall be handled, stored and used in accordance with the manufacturer's recommendations and where applicable, European, British and International Standards.

### **4.5 Variations from materials specified**

4.5.1 Where the Contractor wishes consideration to be made to variations of materials specified, the Contractor shall obtain the approval of the Designer prior to procurement.

### **4.6 Materials complying with the "Specification for Highway Works, Series 600: Earthworks"**

4.6.1 The following materials shall be in accordance with the "Specification for Highway Works, Series 600: Earthworks":

- i) Fill material – capping layer.
- ii) Fill material – general including structures and foundations.
- iii) Gabion boxes and mattresses.
- iv) Gabion fill.
- v) Geotextile – separating membrane.

### **4.7 Tunnelling materials**

4.7.1 Tunnelling materials shall be in accordance with "Specification for tunnelling" published by

British Tunnelling Society and the Institution of Civil Engineers.

## 4.8 Clay puddle stanks

4.8.1 Clay puddle stanks shall be in accordance with GD/SP/CE/1: "Specification for the design, construction and testing of civil and structural works -General".

## 4.9 Fill material – high pressure gas pipework

4.9.1 Bedding, sidefill and initial and main backfill shall be in accordance with IGEM/TD/1: "Steel pipelines for high pressure gas transmission".

## 4.10 Fill material and reinstatement – openings in public highways

4.10.1 Backfill material shall be in accordance with IGEM/TD/1: "Steel pipelines for high pressure gas transmission", whilst reinstatement materials shall be in accordance with "Specification for the reinstatement of openings in highways" published by Highway Authorities and Utilities Committee (HAUC).

## 4.11 Ground anchors

4.11.1 Ground anchors shall be in accordance with the following standards:

BS EN 1537	Execution of special geotechnical work - Ground anchors
BS 8081	Ground anchorages

## 4.12 Piles

4.12.1 Materials for piles shall be in accordance with "Specification for piling and embedded retaining walls" published by the Institution of Civil Engineers and with the following standards:

BS EN 1536	Execution of special geotechnical works. Bored piles
BS EN 1538	Execution of special geotechnical works. Diaphragm walls
BS EN 12063	Execution of special geotechnical works. Sheet pile walls
BS EN 12699	Execution of special geotechnical works. Displacement piles
BS EN 12794	Precast concrete products – Foundation piles
BS EN 14199	Execution of special geotechnical works. Micropiles

4.12.2 Helical / Screw-in piles are relatively new and the most current guidance should be sought in relation to their design and testing.

4.12.3 The requirement for pile testing shall be determined by the Designer.

## **5 WORKMANSHIP**

### **5.1 Specification requirements**

5.1.1 In addition to the requirements of this Specification, materials shall be fabricated, installed, erected and treated in accordance with the manufacturer's instructions and where applicable, European, British and International Standards.

5.1.2 No damaged or non-compliant materials shall be incorporated in the works without approval.

### **5.2 Earthworks - general**

5.2.1 Workmanship shall generally be in accordance with the "Specification for Highway Works, Series 600: Earthworks" with variations as detailed below.

### **5.3 Work on or near operational pipelines**

5.3.1 Work on or near operational pipelines and installations (including new pipelines, which have been tested, and de-commissioned pipelines) shall be carried out only in accordance with GD/SP/SSW/22: "Procedure for safe working and development in the vicinity of pipelines and associated installations operating above 7 barg".

### **5.4 Site clearance**

5.4.1 All materials arising from site clearance or that is unacceptable shall be disposed of offsite to a location licensed to receive the relevant category of waste. Waste Acceptance Criteria (WAC) Testing will be required at most licensed facilities. Guidance can be found in the Environment Agency Guidance on "Waste sampling and testing for disposal to landfill".

5.4.2 Surplus acceptable material shall not be removed from land owned by The Company without approval.

5.4.3 Material from excavations or site clearance on third party land, other than public highways, not required for re-use shall remain the property of the landowner or occupier. The Contractor shall confirm the required ownership of such material in writing with the landowner or occupier.

5.4.4 If the landowner or occupier wishes to retain ownership of such material the Contractor shall comply with the reasonable requirements of the landowner / occupier with respect to the transportation of the material to a place of storage within the same landownership.

### **5.5 Groundwater control**

5.5.1 Earthworks shall be kept free of water at all times during the construction of the works in accordance with the following publications unless otherwise agreed:

Specification for Highway Works. Series 600: Earthworks

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CIRIA Report C515: Groundwater control – Design and practice

5.5.2 Sumps, pumping wells or wellpoints shall be located to avoid instability or deterioration of excavations and formations. Furthermore, the method of groundwater control and surface water removal shall be by separate systems and avoid removal of fines.

5.5.3 The Contractor shall be responsible for obtaining all licenses, permits or consents necessary to works, in or adjacent to, watercourses and / or to discharge to watercourses or drainage systems and / or for the abstraction of water for the temporary works. The Contractor shall comply with any requirements stated in such agreements.

- 5.5.4 Elements of the permanent works or existing installations shall only be used for groundwater control if approved. If approval is given, on completion of their use, they shall be thoroughly cleaned of any silt or debris and be of a similar or better condition compared with their initial takeover by the Contractor.

## 5.6 Mitigation of water pollution

- 5.6.1 Mitigation of water pollution shall be undertaken in accordance with the following publications:

CIRIA report C532: Control of water pollution from construction sites - Guidance for consultants and contractors

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PPG1: General guide to the prevention of pollution, published by the Environment Agency, Scottish Environment Protection Agency and Natural Resources Wales

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PPG6: Working at construction and demolition sites, published by the Environment Agency, Scottish Environment Protection Agency and Natural Resources Wales

## 5.7 Completion of ground reinstatement

- 5.7.1 Ground reinstatement shall be completed within the period 1<sup>st</sup> April to 30<sup>th</sup> September i.e. prior to the end of the planting season.

## 5.8 Works encountering drainage and water mains at depths exceeding 1.5m

- 5.8.1 Works encountering drainage and water mains at depths exceeding 1.5m, where appropriate, shall be in accordance with "Model consultative procedure for pipeline construction involving deep excavation".

## 5.9 Tunnelling

- 5.9.1 Tunnelling shall be in accordance with "Specification for tunnelling" published by British Tunnelling Society and the Institution of Civil Engineers.

## 5.10 Piling

- 5.10.1 Piling shall be in accordance with "Specification for piling and embedded retaining walls" published by the Institution of Civil Engineers.

- 5.10.2 The selection of the installation technique shall take account of the requirements of GD/SP/GM/4: "Specification for the protection of steel pipelines operating at pressures above 7 barg subjected to vibrations caused by blasting, piling or demolition" where piling is required in proximity to existing gas pipework constructed in steel.

## 5.11 Works near Network Rail apparatus

- 5.11.1 Works near Network Rail apparatus shall be undertaken in accordance with GD/SP/G/27: "Specification for installing NGG gas pipes adjacent to and across Network Rail tracks."

## 5.12 Works in public highways

- 5.12.1 Works in public highways shall be in accordance with "Specification for the reinstatement of openings in highways" published by Highway Authorities and Utilities Committee (HAUC).

### 5.13 Capping layers

5.13.1 The workmanship for capping layers shall be in accordance with “Specification for Highway Works, Series 600: Earthworks”, except the minimum area of the capping construction demonstration, shall be the lesser of 70m<sup>2</sup> or the area of the proposed capping construction within the Permanent Works.

### 5.14 Gabions

5.14.1 Gabions shall be constructed in accordance with the manufacturer’s requirements.

### 5.15 Blasting

5.15.1 The use of explosives shall only be used if approved by the Project Manager.

5.15.2 If blasting is approved, it shall comply with the following requirements:

IGEM/TD/1: Steel pipelines for high pressure gas transmission

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Specification for Highway Works Series 600: Earthworks

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GD/SP/GM/4: Specification for the protection of steel pipelines operating at pressures above 7 bar subjected to vibrations caused by blasting, piling or demolition

### 5.16 Excavation for buried high pressure gas pipework

5.16.1 The excavation profile and minimum normal widths for trenches for gas pipelines shall comply with GD/SP/P/10: “Specification for general pipelining designed to operate at pressures greater than 7 barg”.

5.16.2 If narrow trenching techniques are approved, the following minimum trench widths shall be adhered to:

Outside diameter of pipe, mm	Minimum narrow trench width, mm
<= 450	Outside diameter + 100
> 450	Outside diameter + 300

5.16.3 Where the formation of the excavation profile is unsuitable, a minimum 150mm depth of excavation shall be carried out. Bedding material shall be used for building up the formation level such that the replacement material provides a stable bedding as near equivalent to the adjacent formation as is practicable.

5.16.4 Trenches in rock shall be formed such that a minimum 150mm thickness of compacted bedding material is provided.

5.16.5 Over excavation of the trench shall be considered as a variation to the design.

### 5.17 Pipejacks and tunnels

5.17.1 Pipejacks and tunnels used for sleeves to gas pipework shall be in accordance with GD/PM/IGEM/TD/1 and IGEM/TD/1: “Steel pipelines and associated installations for high pressure gas transmission”.

5.17.2 The permitted deviations for pipejacks and tunnels shall be in accordance with the tolerances stated in “Civil engineering specification for the water industry” (CESWI) published by WRc.



## **5.18 Backfilling**

5.18.1 Backfilling shall not be commenced until:

- i) Works to be buried have achieved the necessary strength or have been appropriately jointed / connected / welded, or bolted up.
- ii) Surveys of pipeline or structure alignment and depth have been carried out.

5.18.2 Backfill to pipework or structures (whether to be wholly or partially backfilled) shall be brought up sufficiently evenly on each side and sufficiently evenly along the length of the pipework or structure to avoid instability of, excessive deformation of, or damage to, the permanent works.

5.18.3 Backfilling to pipework shall be in accordance with IGEM/TD/1: "Steel pipelines for high pressure gas transmission".

5.18.4 The main backfill shall be placed in compacted layers not exceeding 300mm thick after backfilling has reached a minimum consolidated height of 150mm above the pipe.

## **5.19 Reinstatement of land and public highways**

5.19.1 Reinstatement of non-public highways shall be in accordance with GD/SP/CE/1: "Specification for the design, construction and testing of civil and structural works - General".

## 6 TESTING

### 6.1 Earthworks - general

- 6.1.1 All testing shall be undertaken by an approved laboratory with UKAS (United Kingdom Accreditation Service) NAMAS (National Measurement Accreditation Services) accreditation, which is independent of the Contractor and supplier.
- 6.1.2 Testing and acceptance criteria shall be in accordance with the BS 6031 'Code of practice for earthworks' which is itself based on "Specification for Highway Works, Series 600: Earthworks".
- 6.1.3 Material shall be tested for acceptability using the following guidelines:
- a. Class 1 General granular fill.
    - i. Grading/uniformity coefficient - twice a week.
    - ii.  $mc/MCV - 2$  per  $1000m^3$  up to max. of 5 per day.
  - b. Class 2 General cohesive fill.
    - i. Grading/uniformity coefficient - twice a week.
    - ii.  $mc/MCV/PL$ , Undrained shear strength – 2 per  $1000m^3$  up to max. of 5 per day.
    - iii. SMC of chalk – Twice a week.
    - iv. Bulk density (pfa) - 2 per  $1000m^3$  up to max. of 5 per day.

### 6.2 Testing of compaction

- 6.2.1 The testing rate of compacted material shall be as follows:
- i. For areas compacted by 'method' compaction as detailed in "Specification for Highway Works, Series 600: Earthworks", in-situ density testing in accordance with BS 1377: "Methods of test for soils for civil engineering purposes. Part 9: In-situ tests" shall be carried out as instructed to determine the field dry density. The designer shall specify the number of tests required or the frequency of testing.
  - ii. For areas compacted by 'end product' compaction as detailed in "Specification for Highway Works, Series 600: Earthworks", the following testing shall be undertaken at least 7 days prior to commencement of end product compaction: optimum  $mc$ /maximum dry density (2.5.kg rammer/vibrating hammer method) – each class or subclass of material.
- 6.2.2 For the material placed by 'end product' compaction, in-situ density tests in accordance with BS 1377: "Methods of test for soils for civil engineering purposes. Part 9: In-situ tests" shall be carried out at a rate of one per 200 tonnes of placed material but not less than one test per class or sub-class of material. For each such test the Contractor shall additionally allow for carrying out a determination of the maximum dry density and optimum moisture content using the values provided by BS 1377: 2.5kg, 4.5kg or vibrating hammer method as appropriate to the material type and design requirement for the fill.
- The Designer shall state the percentage (90 or 95) of maximum dry density that needs to be achieved by the 'end product' compaction.
- 6.2.3 Where there is an unacceptable risk of collapse compression upon groundwater inundation for deep fill areas/buildings and structures, there shall be an additional requirement for all fill to be compacted to < 5% air voids.

## 6.3 Testing of piles

6.3.1 Testing of piles shall include for 'integrity' testing of all cast in-situ piles or barrettes and 'load testing' of 5% of the piles (but not less than two number) by appropriate methods as described in the "Specification for piling and embedded retaining walls" published by the Institution of Civil Engineers. The above 'load testing' requirement shall apply to each number in the following groups of piles designed to accept:

- i) Compression loads.
- ii) Tensile loads.
- iii) Lateral loads.

6.3.2 At least one of the static load tests on each of compression piles and tension piles shall comply with the 'extended proof load test procedure'.

6.3.3 The particular piles to be tested shall be agreed with the Designer or Project Manager.

6.3.4 Piles can be tested in-situ using dynamic and static tests to ascertain if they are meeting design criteria. The number and locations of the tests should be agreed with the Designer.

## 6.4 Level monitoring of gas plant supports and foundations at above ground installations

6.4.1 Where specified by the Designer or Project Manager, level monitoring of the uppermost surface of each gas plant support or foundation at agreed locations shall be undertaken for performance monitoring of foundation and assessment of the stress states within pipework and / or gas plant. The timing of the surveys shall be as follows:

- i) Upon completion of foundation, support and pipework installation, but prior to any hydraulic pressure test of the relevant section of pipework.
- ii) Following any hydraulic pressure test of the relevant section of pipework.
- iii) Immediately after the agreed substantial completion of the overall works.

6.4.2 The Contractor shall provide at least three level monitoring reference points with levels established to Ordnance Datum Newlyn. Such level monitoring reference points shall be of an agreed construction and anchored at least one metre below finished ground level to mitigate the effects of seasonal ground movement in the near-surface zone.

6.4.3 The results of each survey shall be provided immediately after each survey in an agreed format incorporating annotated drawings with the monitoring locations in plan and elevation and reference numbers. For surveys subsequent to the first, the reports shall include evaluation of any apparent movements along with tabulated incremental movement and a graphical representation of the movement on a true time axis.

## 6.5 Testing requirement in Geotechnical Design Report

6.5.1 A note of items to be checked during construction or requiring monitoring as described above shall be included in the Geotechnical Design Report, as detailed in BS EN 1997-1.

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