IGEM/SR/28 Edition 2
Communication XXXX

Founded 1863
Royal Charter 1929
Patron
Her Majesty the Queen

TRENCHLESS TECHNIQUES

DRAFT AFTER COMMENT

1 This draft Standard IGEM/SR/28 Edition 2 has been prepared by a Panel under the chairmanship of Steve Murray.

2 This Draft for Comment is presented to Industry for comments which are required by 30th July 2010, and in accordance with the attached Comment Form.

3 This is a draft document and should not be regarded or used as a fully approved and published Standard. It is anticipated that amendments will be made prior to publication.

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Attached is the Draft for Comment of "Trenchless Techniques" and the associated Comment Form.

Organisations to which this Draft has been circulated:

- Association of Independent Gas Transporters (AIGT)
- British Drilling Association Ltd
- BSI
- CITB
- Distribution Network Operators
- Drilling and Sawing Association
- Energy Institute
- Energy Networks Association
- Gas Industry Safety Group (GISG)
- Highways Agency
- HAUC
- HSE
- Institute of Highway Incorporated Engineers
- Institution of Highways and Transportation
- ISTT
- NJUG
- Ofgem
- Pipe Jacking Association
- SBGI
- UKSTT
- Utility infrastructure providers:
  - Balfour Beatty Utilities
  - Avent Engineering
  - Primeshade Contracts
- Trade Associations for:
  - water – Water UK
  - communications companies – Federation of Communication Services

All IGEM Committees and Panels.

IGEM
Institution of
Gas Engineers & Managers

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Trenchless techniques

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For information on other IGEM Standards please visit our website, www.igem.org.uk

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SECTION 1 : INTRODUCTION

1.1 IGE/SR/26, Communication 1662, entitled Horizontal Directional Drilling and Impact Moling, was first published by the Institution of Gas Engineers and Managers (IGEM) in 1999. IGE/SR/28, Communication 1680, entitled Trenchless Techniques was first published by the Institution of Gas Engineers and Managers (IGEM) in 2002. This Standard, IGEM/SR/28 Edition 2, supersedes Communications 1662 and 1680 which are now withdrawn and are obsolete.

1.2 This Standard has been drafted by a Panel appointed by IGEM's Gas Transmission and Distribution Committee and published by the authority of the Council of IGEM.

1.3 This Standard provides requirements to those responsible for the planning of trenchless technology works, the operation of equipment and the application of processes used to carry out work.

1.4 The advantages of trenchless techniques are in the ability to install new, and replace or renovate existing underground utilities and services with minimal disturbance to the surface or damage to other buried services, thereby reducing above-ground activities and eliminating the need for costly and disruptive reinstatement. These advantages open up opportunities for installation in difficult or otherwise prohibitive expensive locations, for example:

- beneath highways, access ways to plant and other surfaced areas
- beneath railways
- beneath water courses, estuaries and lakes
- at sites of special scientific interest (SSI)
- beneath structures and plant installations.

1.5 This Standard draws attention to those aspects of the examination, lining, repair and installation of underground duct, pipe, cable and service tunnels, using trenchless equipment and techniques which could put operators and persons working nearby and members of the public at risk, or could lead to damage and disruption of existing services, for example:

- effects of collateral damage to adjacent buried plant and services
- damage in respect of heave or shrinkage of the ground surface.

1.6 This Standard makes use of the terms "must," "shall" and "should" when prescribing particular requirements. Notwithstanding Sub-Section 1.8:

- the term "must" identifies a requirement by law in Great Britain (GB) at the time of publication
- the term "shall" prescribes a procedure which, it is intended, will be complied with in full and without deviation
- the term "should" prescribes a procedure which, it is intended, will be complied with unless, after prior consideration, deviation is considered to be acceptable.

Such terms may have different meanings when used in legislation, or Health and Safety Executive (HSE) Approved Codes of Practice (ACoPs) or Guidance, and reference needs to be made to such statutory legislation or official guidance for information on legal obligations.

1.7 The primary responsibility for compliance with legal duties relating to health and safety at work rests with the employer. The fact that certain employees, for example "responsible engineers" are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities.

Employers must:

- have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers"
- have done everything to ensure, so far as is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement
- have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review
- not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is not within their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their professional judgement. When "responsible engineers" are asked to undertake tasks which deviate from this they should refer the matter for higher review.

1.8 Notwithstanding Sub-Section 1.6, this Standard does not attempt to make the use of any method or specification obligatory against the judgment of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for the modification of this Standard. Amendments to this Standard will be issued when necessary and their publication will be announced in the Journal of IGEM and other publications as appropriate.

1.9 It is now widely accepted that the majority of accidents in industry generally are in some measure attributable to human as well as technical factors. People who initiated actions that caused or contributed to accidents might have acted in a more appropriate manner to prevent them.

To assist in the control of risk and proper management of these human factors, due regard should be taken of HSG48.

1.10 Requests for interpretation of this Standard in relation to matters within its scope, but not precisely covered by the current text, should be addressed to Technical Services, IGEM, IGEM House, High Street, Kegworth, Derbyshire, DE74 2DA or email to technical@igem.org.uk. Such requests will be submitted to the relevant Committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEM, this does not imply acceptance of any liability for the consequences and does not relieve the responsible engineer of any of their obligations.

SECTION 2 : SCOPE

2.1 This Standard addresses health, safety and environmental matters associated with the following trenchless disciplines:

- impact moling
- horizontal directional drilling (HDD)
- auger boring and rotary drilling
- pipe ramming and pipe jacking
- pipe splitting and pipebursting
- refurbishment of pipes using lining techniques
- internal pipe repair system(s)
- microtunnelling (up to 1 m diameter).

Note: Guidance on high pressure cleaning, pipe inspection and blast cleaning operations are given in appendices 8, 9 and 10 respectively.

2.2 This Standard gives requirements and is not, intended to relate to the specific performance capabilities of any particular system. Manufacturers' safety and operational manuals need to be available and those more detailed safety and operational procedures implemented.

Note: It is not feasible to provide definitive dimensional guidance on the depth, diameter and length of a bore, as these dimensions vary dependent on the equipment used and site-specific conditions. Therefore, it is essential that the equipment manufacturer's guidelines are followed in their entirety.

SECTION 3 : LEGAL AND ALLIED CONSIDERATIONS

3.1 GENERAL

3.1.1 This Standard is set out against a background of legislation in force in the UK at the time of publication. Similar considerations are likely to apply in other countries and reference to appropriate national legislation will be necessary.

Appendix 2 lists legislation, guidance notes and Standards etc. which are identified within this Standard as well as further items of legislation that may be applicable.

Where Standards are quoted, equivalent national or international Standards, etc. equally may be appropriate.

Unless otherwise stated, the latest version of the referenced document should be used.

3.1.2 Health and safety legislation must be observed, including those requirements concerned with the duties of employers towards both their employees and other persons, including members of the public whose safety may be affected.

In the absence of specific legislation, it is essential that installations are designed, constructed, installed, operated and maintained so as to be safe.

3.2 PRIMARY LEGISLATION

3.2.1 Control of Pollution Act (COPA)

3.2.1.1 A certain amount of noise is inherent in operation and maintenance activities. The best practicable methods should be employed to minimise noise emission, to protect site personnel and the public. Any relevant legal requirements must be applied.

3.2.1.2 Consideration should be given to the following:

- provision of suitable ear protection to site personnel
- siting and screening of plant
- use of acoustically-treated power tools, compressors and generators
- the timing of all operations and maintenance activities, which should take into account the impact on the environment.

3.2.1.3 Noise is a major issue both for designers (who should endeavour to "design out" noisy processes, wherever possible) and managers of construction or demolition sites where the potential of nuisance should be recognised at the earliest possible stage.

3.2.1.4 Part III of COPA relates to construction site noise, which is subject to noise abatement zones and licensing enforcement by the local authorities. Local authorities have powers to control noise (and vibration) on or from building sites. This control is by the service of a notice placing obligations on the person responsible for the construction operations to observe specified controls to minimise noise. Such a notice can specify types of plant and machinery, permitted hours of operation, boundary noise levels, etc.

3.2.1.5 When drawing up such requirements, the local authority has regard to any code of practice approved or issued under COPA. It must also have regard to the concept of "best practicable means" and any alternative plant or machinery which may be used. BS 5228 has been adopted for this purpose. Although the standard has been adopted under COPA, it is not legally binding in itself.

However, the content of each relevant part of the standard should be taken to represent current good practice.

3.2.1.6 Noise abatement zones are established essentially for the purposes of rationalising competing sources of noise, particularly where industrial premises and domestic premises are in proximity. Local authorities are required to keep registers of noise levels of specified premises within noise abatement zones.

3.2.2 Environmental Protection Act (EPA)

3.2.2.1 *Waste*

3.2.2.1.1 Waste is defined in Schedule 22 of the Environment Act as any substance or object which a holder discards or intends, or is required, to discard. This definition is based upon an EC Directive and is, therefore, known as "directive waste". "Controlled waste" is defined by EPA as "household, industrial and commercial waste". Controls under EPA, for example licensing requirements and the Duty of Care, apply only to "controlled waste" that is also "directive waste".

3.2.2.1.2 Section 34 of EPA introduced a duty of care for waste management. The duty of care applies to anyone who produces, imports, carries, keeps, treats or disposes of controlled waste. There are a number of objectives, outlined below, which duty holders should achieve, as is reasonable in the circumstances.

3.2.2.1.3 Every person who is subject to the duty of care must ensure not only that they do not commit an offence but that any other person does not similarly commit offence. In practice, this means that a waste holder is responsible for taking steps to prevent offences involving waste that they have controlled at some point. They must try to prevent other people from disposing of, treating or storing the waste:

- without a licence
- breaching the conditions of a licence
- in a manner likely to cause pollution or harm to health.

3.2.2.1.4 The producer or importer of waste must package it in such a way as to prevent escape of leakage while on site, in transit or in storage. The waste producer or holder must ensure that waste is only transferred to an authorised person. The categories of authorised persons are:

- a waste collection authority
- the holder of a waste management licence or someone who is exempt from holding a licence
- a registered carrier of controlled waste, or someone who is exempt from registration
- in Scotland, a waste disposal authority.

In addition, an accurate, written description of the waste must be provided by the producer or importer of the waste and transferred with the waste at each stage.

3.2.2.2 *Noise*

3.2.2.2.1 Part II of EPA relates to statutory nuisances, which include noise nuisances. Statutory nuisances are defined as including circumstances in which noise is emitting from premises so as to be prejudicial to health or a nuisance. The local authority can serve an abatement notice and enforce it in criminal proceedings before a magistrate's court in the event of non-compliance without reasonable excuse.

3.2.2.2.2 The Noise and Statutory Nuisance Act amends EPA to make noise from vehicles, machinery or equipment in the street a statutory nuisance. If the local authority is satisfied that noise from vehicles, machinery or equipment in the street is causing, or is likely to cause, a nuisance, it must serve an abatement notice on the person responsible.

3.2.2.2.3 The aim of the Control of Noise at Work Regulations (see Sub-Section 3.3.4) is to reduce the risks of occupational hearing damage to as low as reasonably practicable.

There are, among others, legal duties to:

- protect the hearing of those at work and of others
- carry out a noise assessment if employees are exposed to noise levels exceeding 85 dB(A)
- take measures to reduce noise levels to the lowest level reasonably practicable
- use warning signs to indicate where hearing protection must be worn
- inform workers about risks to hearing.

3.2.2.2.4 HSL108 is designed to give those with responsibilities for reducing noise exposure guidance and advice on legal duties on the introduction of control measures, the selection of ear protection and how to carry out a noise assessment by a competent person.

3.2.3 Health and Safety at Work etc. Act (HSWA)

3.2.3.1 HSWA sets out general duties which employers have towards employees and members of the public and which employees have to themselves and to each other. It is also the "umbrella" under which health and safety regulations are made.

3.2.3.2 Employers' duties of care with regard to the health and safety of their employees are set out in Section 2 of HSWA which contains a general statement of the duties of employers to their employees while at work, including:

- the provision and maintenance of plant and systems of work that are safe and without risks to health
- ensuring that the use, handling, storage and transport of articles/substances is safe and without risk
- the provision of information, instruction, training and supervision.

3.2.4 New Roads and Street Works Act (NRSWA)

3.2.4.1 NRSWA and the associated Regulations lay down standards of service and performance for all statutory and licensed Undertakers in the execution of their statutory rights to excavate within the public highway.

Note: Whereas NRSWA itself is specific to Undertakers, it is probable that a significant proportion of trenchless technology would be carried out on behalf of Undertakers, under NRSWA and, in that respect, a thorough knowledge of the provisions of NRSWA is required before commencing any work in public highways.

3.2.4.2 Under certain sections of NRSWA, Codes of Practice (CoPs) have been issued by the Secretaries of State for Transport, Wales and Scotland. These give practical guidance on certain matters. In instances where an Undertaker fails to comply with its duties under these Sections, the Undertaker commits an offence. This amplifies the need for a thorough working knowledge of the provisions of NRSWA.

Note: Associated CoPs include:

- *Co-ordination of Street Works for Road Purposes and Related Matters – (Blue Book)*
- *Specification for the Reinstatement of Openings in Highways – (Yellow Book)*
- *Measures Necessary where Apparatus is Affected by Major Works [Diversionary Works] – (Grey Book)*
- *Inspections – (Pink Book)*
- *Safety at Street Works and Road Works (Red Book)*
- *Recording of Underground Apparatus in Streets (Lilac Book).*

These CoPs are continuously monitored by working parties set up by the Highway Authorities and Utilities Committee (HAUC), which may issue supplementary Advice Notes, or revisions to the various CoPs from time to time.

3.3 SECONDARY LEGISLATION

3.3.1 Confined Spaces Regulations

These Regulations apply to a large range of confined spaces. The supplier or designer of an enclosure and equipment within it is required to perform a risk assessment of the enclosure with respect to safe access and egress and to give clear instructions to operators on access/egress as well as to what actions to take in the event of a gas alarm occurring. Employers and the self employed should prevent entry into confined spaces unless avoidance in not reasonably practicable and unless there is a system of work which renders the work safe. They are also required to have specific emergency arrangements in place. Practical guidance is provided in HSL101.

3.3.2 Construction (Design and Management) Regulations (CDM)

3.3.2.1 CDM apply to almost all construction work. Trenchless techniques, used on projects such as the installation of an area cable television network or the installation of a utility service, would be subject to CDM, as would trenchless techniques used as part of virtually all civil engineering construction or building work. Where CDM do not apply, the principles of good construction management which they embody should be adhered to.

CDM impose duties on designers, clients (and their agents), developers, CDM Co-ordinator and principal contractors. Not all the regulations apply to all construction projects. Further information is given in HSL144. For a notifiable project (as defined in CDM) the CDM Co-ordinator must notify HSE before construction work commences. Construction includes the alterations, repair, redecoration, maintenance, decommissioning and demolition of a structure. It also covers installation, commissioning, maintenance or removal of gas services.

The duties include requirements that:

- employers, so far as is reasonably practicable, provide a safe working place with sufficient working space, including suitable access to and egress from the working place
- precautions be taken to prevent people falling as a result of openings, edges and the like. This requires the provision of shuttering, shoring, barriers, scaffolds, ladders, safety nets or safety harnesses and the like
- excavations be supported whenever the nature of the work being carried out in the excavation and the ground conditions make the provision of such support necessary
- employers provide certain health and welfare provisions on site, with each employee having adequate access to them. Such provisions include accommodation for bad weather sheltering, messing, storage of working clothes and drying facilities, together with washing and sanitary facilities.

3.3.3 Construction (Head Protection) Regulations

Under these Regulations, employers are required to provide, maintain and replace, as necessary, suitable head protection for their employees and others working in the areas over which they have control. Employers must ensure that the head protection is worn unless there is no risk of a head injury occurring other than by falling over.

3.3.4 Control of Noise at Work Regulations

3.3.4.1 These Regulations require employers to make and review noise assessments and to keep relevant records. The risk of damage to the hearing of employees from exposure to noise must be reduced. Noise must be eliminated or reduced at source so far as is reasonably practicable and before the issue of hearing protection is considered.

3.3.4.2 Hearing protectors must be worn by employees entering a hearing protection zone.

3.3.4.3 Employees likely to be exposed to a level of noise above the specified action level must be provided with adequate information.

3.3.5 Control of Substances Hazardous to Health Regulations (COSHH)

3.3.5.1 COSHH, which reinforce existing statutory obligations under HSWA, impose a duty on employers to protect employees against risks to health, whether immediate or delayed, arising from exposure to substances hazardous to health, either used or encountered, as a result of a work activity. They also impose certain duties on employees.

3.3.5.2 Under COSHH, work must not be carried out which is liable to expose employees to hazardous substances unless the employer has made a suitable and sufficient assessment of the risk created by the work and the steps that need to be taken to comply with COSHH. After assessing the risk, it is necessary to inform employees of the risks and to carry out the appropriate training and instruction to ensure the risks are minimised. In certain cases, control measures such as ventilation or PPE may be necessary and, where provided, they must be used. Practical guidance can be found in HSL5 and leaflet INDG136.

3.3.6 Electricity at Work Regulations

These Regulations apply to electrical installations at work and equipment using electrical energy.

They are concerned with the prevention of danger from electric shock, electric burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.

In general, the following apply:

- systems must be designed, constructed and maintained so as to prevent danger
- electrical equipment must not be used if its strength and capability may be exceeded, so giving rise to danger
- electrical equipment which may be exposed to adverse or hazardous environments must be constructed to, or protected in such a way as to, prevent danger
- all conductors must be either insulated or protected so as to prevent danger
- in order to prevent danger when a conductor becomes charged either through use or a fault, earthing or other suitable means must be provided

- if a circuit conductor is connected to earth, nothing must be introduced into the conductor which breaks the circuit or introduces a high impedance unless suitable precautions are put in place to prevent danger
- all connections must be mechanically and electrically suitable for use
- all means to protect the circuit from excess current must be provided
- means must be provided for cutting off and isolating the supply
- electrical equipment made dead for the purpose of carrying out work must be prevented from becoming live
- work must not be carried out on live conductors unless it is unreasonable for it to be dead, it is reasonable for the work to be carried out, and suitable precautions have been taken to prevent injury
- adequate working space, lighting and means of access must be provided.

They impose duties on every employer, employee and self-employed person and require that persons engaged in electrical work be competent or be supervised by competent persons.

Note: A "Memorandum of Guidance on the Electricity at Work Regulations, 1989" is available from HMSO and gives useful information on the Regulations. Further advice is contained in HSR25.

3.3.7 Lifting Operations and Lifting Equipment Regulations (LOLER)

LOLER deal specifically with the lifting aspects of work equipment and the control of lifting operations.

Practical guidance on LOLER is given in HSL113.

3.3.8 Management of Health and Safety at Work Regulations (MHSWR)

MHSWR apply to all work activities involving services and require, among other things, that employers assess the risks to the health and safety of their employees and of persons not in their employment but who may be affected by their activities, and then to make appropriate arrangements for preventative and protective safety measures.

3.3.9 Manual Handling Operations Regulations

These Regulations seek to reduce the very large incidence of injury and ill-health arising from the manual handling of loads at work. More than 1 in 4 of all reportable injuries are caused by manual handling. These accidents do not include cumulative injuries, particularly to the back which can lead to physical impediment or even permanent disablement.

The Regulations place duties upon employers in respect of their own employees. Identical duties are placed on the self-employed in respect of their own safety.

3.3.10 Personal Protective Equipment at Work Regulations

Personal protective equipment (PPE) includes waterproof clothing, gloves, safety footwear, high visibility waistcoats, eye protectors, respirators, safety harnesses and the like. An employer is required to provide suitable PPE to any employee who may be exposed to risk at work.

3.3.11 Pipelines Safety Regulations (PSR)

PSR replace earlier prescriptive legislation for both onshore and offshore pipelines and include new provisions such as arrangements for a Major Accident Prevention Document (MAPD) and for emergency plant. There are also specific

regulations that no person shall cause such damage to a pipeline as may give rise to a danger to persons (Regulation 15) and for prevention of damage by providing information on the existence and whereabouts of pipelines (Regulation 16).

Note: HSL81 provides an ACoP and guidance and HSL82 provides guidance on PSR.

3.3.12 Pressure Systems Safety Regulations (PSSR)

PSSR impose duties on designers, importers, suppliers, installers and users or owners to ensure that pressure systems do not give rise to danger. This is done by the correct design installation and maintenance, provisions of information, operation within safe operating limits and, where applicable, examination in accordance with a written scheme of examination drawn up or approved by a competent person (as defined by PSSR).

Relevant fluids for the purpose of this document would be Natural Gas at a pressure greater than 0.5 bar above atmospheric pressure. A pressure system would include bulk storage tanks, pressure vessels, pipelines and protective devices. Once the pressure in the pipework drops below 0.5 barg, and the user/owner can show clear evidence that the system does not contain, and is not liable to contain, a relevant fluid under foreseeable operating conditions, then that part of the system is no longer covered by the Regulations. This is likely to be the case after the pressure relief valve associated with a pressure reducing valve which takes the pressure to below 0.5 bar, for example at the entry to a building.

Note the special requirements placed on protective devices in such systems (see paragraph 110b of HSL122). The regulations also apply to pipelines and their protective devices in which the pressure exceeds 2 barg (see Sch 1, part 1, item 5 of HSL122).

More information is available in HSL122 and some information is presented in INDG261 and INDG178.

3.3.13 Provision and Use of Work Equipment Regulations (PUWER)

3.3.13.1 PUWER place duties on employers in relation to selection, suitability, maintenance, inspection, installation, instruction and training, prevention of danger and control of equipment.

3.3.13.2 Work equipment has a wide meaning and in addition to lifting equipment, horizontal directional drilling rigs and machinery, includes hand tools, portable power tools, laboratory apparatus (for example, Bunsen burners), ladders, photocopiers etc. for use at work.

3.3.13.3 More information on PUWER can be found in HSL22. Free leaflets include INDG291 and INDG229.

3.3.14 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)

3.3.14.1 RIDDOR require employers, self employed people or those in control of work premises to report certain work related accidents, diseases and dangerous occurrences.

3.3.14.2 Other people have duties to report certain gas incidents which may not appear to be work related:

- death or major injury arising out of the distribution, filling, import or supply of NG or LPG should be reported by the conveyor for NG and the filler, importer or supplier for LPG.
- dangerous gas fittings (as defined in RIDDOR) should be reported by a "member of a class of persons".

3.3.14.3 Major injuries, death and dangerous occurrences must be notified immediately, for example by telephone, to the enforcing authority by the "responsible person" as defined by RIDDOR. Reports can be made to the Incident Contact Centre by:

- telephone on 0845 300 9923
- email to riddor@connaught.plc.uk
- internet at www.hse.gov.uk/riddor or
- via a link from HSE website at www.hse.gov.uk.

3.3.14.4 It is also possible to report to the local HSE office by telephone and then follow up with a written report on the correct F2508 form within the required timescale (10 days, or 14 days for dangerous gas fittings). Other reports should be made as soon as practicable and within 10 days of the incident.

3.3.14.5 HSL73 contains detailed guidance on RIDDOR, including a full list of injuries etc. that need reporting.

3.3.15 Supply of Machinery (Safety) Regulations

These Regulations implement the requirements of the European Community (EC) Machinery Directive (as amended). The text of the Directive is contained within the Regulations. They apply to manufacturers and suppliers of machinery and set out essential requirements for all machinery.

Note: Section 6 of HSWA, relating to plant and machinery safety, remains in force.

3.4 EUROPEAN STANDARDS

The following European standards are directly relevant and have been published in UK as BS EN Standards:

- BS EN ISO 12100 on Safety of machinery
- BS EN 791 on Drill rig safety.

SECTION 4 : PREPARATION OF A SAFETY PLAN

4.1 INTRODUCTION

4.1.1 Any trenchless technique shall be planned with the objectives of minimizing risk to operatives, installations below and above ground and members of the public. Care should be taken in selecting the methods and equipment most suited to the task which will overcome the identified hazards both above and below ground. This section provides requirement on the issues that shall be considered when preparing a Safety plan to use with any of the methods included in the scope.

4.1.2 A detailed Safety plan shall be established at the project planning stage and should address the following issues:

- full knowledge and agreement to the proposed works and compliance with the requirements of users of the site, utility companies or third parties if the proposed works could affect their infrastructure

  Note: This is to maintain the integrity and safety of existing apparatus.

- all works to be undertaken in compliance with any safety regulations and conditions applicable to the site. All appropriate safety barriers shall be to current street works code of practice to ensure the safety of the site operators and of persons who could come into close proximity to the proposed works. This includes all operational areas on the site. Further guidance is given in the NRSWA Code of Practice "Safety at Street Works and Road Works"
- all works to be undertaken in compliance with environmental regulations.

4.2 CONSTRUCTION PHASE PLAN

4.2.1 The Principal Contractor and other contractors must identify the hazards and assess the risks relating to their work, including the risks they create for others. Using this information, Regulation 23 of CDM requires the Principal Contractor to prepare a construction phase plan which is sufficient to ensure that the construction phase is planned, managed and monitored in a way which enables, so far as is reasonably practicable, the construction work to be carried out without risk to health or safety. This includes incorporating information provided by the client and CDM Coordinator in the plan. The Construction Phase Plan should be sufficiently completed before the client allows work to proceed on site.

The Construction Phase Plan is the foundation for good management and clarifies:

- who does what
- who is responsible for what
- the hazards and risks which have been identified
- how the works are to be controlled.

4.2.2 For all but the simplest of projects, the plan may not be sufficiently developed when construction work begins to cover all of the work that the project will involve. It may only cover early phases of work (for example site set up, enabling works, clearance and early groundworks). However, the plan at this phase should indicate how arrangements for managing the rest of the work will be added as contractors and sub-contractors are identified and can give meaningful input to their part of the plan.

4.2.3 The plan should be regarded as a live document, reviewed at regular intervals and, where necessary, amended to reflect changes in the scope of work or programme changes, where the planned interface of trades may alter.

4.2.4 The plan should be structured to reflect the following information:

- description of project
- management of the work
- arrangements for controlling significant site risks, including safety, health and environmental risks
- the health, safety and environmental file.

4.2.5 Responsibility for carrying out the location of underground plant shall be clearly defined.

Note: The frequency and number of trial holes required on site will be determined following the site survey and the risk assessment.

4.3 INFORMATION

4.3.1 General

4.3.1.1 Information critical to the process of preparing the Site Safety Plan, common to most techniques and sites, should be sourced within the following documents:

- contract specification
- project drawings
- pre tender health and safety plan
- utility companies' asset records
- site investigation reports
- Ordnance survey maps
- HSE guidance.

Note: Appendix 3 lists organisations who can provide safety information.

4.3.1.2 Other sources of information shall be considered, dependent upon the specific job type and the technique to be used, for example:

- for major road crossings - the Highways Authority (Highways Agency, Transport Scotland, Transport Wales etc.)
- for rail and tramway crossings – Network Rail/Northern Ireland Railways or tramway operator
- for rivers and canals - the Environment Agency, Scottish Environment Protection Agency, Northern Ireland Environment Agency, British Waterways
- for industrial plants - the plant operators/owners
- for agricultural or green field sites – DEFRA, local authority, land owner
- for fuel/oil pipelines and associated plants – BDA, Mainlines, MOD, etc
- for areas of outstanding natural beauty or national scenic areas(Scotland) – Countryside Agency (England), Northern Ireland Environment Agency (Northern Ireland), Countryside Council for Wales or Scottish Natural Heritage
- for sites of special scientific interest or areas of special scientific interest (Northern Ireland) - Countryside Agency (England), Northern Ireland Environment Agency (Northern Ireland), Countryside Council for Wales or Scottish Natural Heritage.

4.3.2 Site survey

4.3.2.1 All sites should be visited and thoroughly inspected by operational and health, safety and environmental personnel to determine the topography, the suitability of the exit and entry points, surface features and surface evidence of buried services or structures to ensure the accuracy of the initial site information, and

to gather detailed information for assembly of the Safety Plan. The site survey should ensure that all utility plans are available on site, including gas, water, electricity, telecommunications, cable, sewer, storm water drains, and indicate the presence of any third party pipelines that may be present. The presence of all buried plant should be confirmed and marked on the ground.

4.3.2.2 Where pipelines are proposed through environmentally sensitive areas, for example within SSSI, an Environmental Statement must be submitted to the Secretary of State.

Note: SSSI sites and projects involving special engineering difficulties may significantly increase planning time and this has to be allowed for in the project development plan.

4.3.2.3 If hazardous underground plant is identified and potentially affected, the relevant network owner should be contacted for appropriate precaution measures.

Note: This includes all utility networks, as in the event of a high pressure water main being damaged, flooding and possibly road collapse due to soil washout.

4.3.2.4 Evidence of recent redevelopment or ground disturbance should be taken into account, as it could be of significant importance or could indicate the presence of buried assets.

Note: For example, if the ground levels have changed, existing services could be at a different depth to that anticipated and this would need to be taken into account when planning the works.

4.3.2.5 Having gathered information for the safety plan, a review should be undertaken to confirm:

- the feasibility of the chosen technique for the project
- that the plant and equipment available is fit for purpose.

Note: For example, would it be used within its operational limits?

With the foregoing confirmed, the next stage of planning should be the preparation of a detailed installation safety plan, which is specific to the technique to be used and the particular site.

4.4 OPERATIONAL ISSUES RELEVANT TO THE PREPARATION OF A SAFETY PLAN FOR ALL TECHNIQUES

4.4.1 General issues

When preparing a safety plan, consideration shall be given to the following:

- working within confined spaces
- assessing hazards from noise
- working within open excavations such as launch and reception pits
- determining the nature of, and dealing with, any hazardous waste
- dealing with adverse traffic and weather conditions
- dealing with high flow conditions in existing and adjacent pipelines and the environmental impact of any flow control
- establishing safe methods of work and determining the number of personnel required
- determining the construction and condition of any adjacent pipeline to confirm that the chosen technique or process can be safely utilised
- assessing the potential for damage to the surface above any pipe or to adjacent properties etc. as a result of pipeline installation operations

- determining potential hazards from pipeline installation/repair processes which are specific to the technique chosen
- assessing the potential hazards of using lubricants such as bentonite, soil conditioners and ground contaminants
- assessing potential hazards in handling materials and equipment used in pipeline installation processes, for example pipe type, diameter, bending characteristics etc.
- determining potential hazards from ancillary operations such as steel pipeline welding
- determining potential hazards of working with both pneumatically and hydraulically powered equipment, for example, protection of hoses from impact damage
- the use of non-flammable hydraulic fluids
- assessing the appropriateness of all plant and equipment for the purposes it is to be used
- assessing potential hazards of using specialist plant such as winches, coil trailers, polyethylene pipe welding equipment etc.
- determining waste disposal provisions
- other utility networks.

4.4.2 **Ground conditions**

4.4.2.1 Consideration shall be given to the existing ground conditions and how they will impact on the chosen technique. Particular attention should be given to the prevailing groundwater conditions.

4.4.2.2 Reference should be made to the manufacturers' instructions to assess the suitability of the ground against the capability of the equipment.

4.4.2.3 The effects of ground movement on adjacent underground equipment and resultant surface heave should be assessed. Utility companies' recommended safe working distances from their buried plant should be maintained. Requirements with respect to gas pipelines are given in IGE/SR/18. Consideration shall also be given to the depth of the installation, to avoid potential ground heave at the surface.

4.4.3 **Underground obstructions**

4.4.3.1 Care should be taken in identifying any underground structures and, where appropriate, detailed plans and recommendations should be obtained from the owner.

Note: This is particularly relevant where access excavations are to be positioned as additional space may be required to accommodate equipment and materials.

4.4.3.2 The position of any known natural or artificial obstructions should be determined using existing records.

4.4.3.3 Consideration shall be given to the avoidance of tree roots. Further guidance is given in NJUG Volume 4.

4.4.4 **Bore route plans**

A bore route plan should be confirmed on site before commencement of the installation works.

Special consideration shall be given to:

- works below the water table or those influenced by tidal conditions
- physical or artificial obstructions along the route of the installation, for example boulders, foundations or piles.

4.4.5 Special engineering difficulties

4.4.5.1 On major projects, (for example a river crossing) geological and structural profiles shall be confirmed on site before commencement of any works. When drilling is likely to be carried out in the proximity of a tidal watercourse, the implications shall be identified and control measures put in place. Similarly, for other major crossings, such as rail, motorway, canal, subways, etc., detailed information on their below ground construction should be sought. Specific protection measures, if required, should be identified and put in place.

4.4.5.2 When crossing rivers, watercourses, etc. the enforcing agency should be contacted to determine the minimum depth below the bed.

4.4.5.3 The design of a pipeline at a water crossing should not be less onerous than that required for a land pipeline and should take into account the following additional features within the selected pipeline crossing:

- type and intensity of shipping, fishing and other recreational or commercial activities
- presence of ship anchoring, dredging and dumping and of other services laid within/across
- the currents, stability and erosion of the banks and beds
- coating, corrosion protection requirements
- operational requirement, including consideration of strategic valves
- future plans identified by the local planning authority.

4.4.5.4 The design should identify all foreseeable events, the likelihood and consequences of occurrence and mitigation of identified risks.

Note: Further guidance and requirements are contained in IGE/TD/3.

4.4.6 Water supply licence

4.4.6.1 Any operations that require a supply of water for the drilling fluid need a Water Authority licence, where water standpipes of greater than 50 mm nominal diameter are needed. This should be sought during the planning stage.

4.4.6.2 Detailed information on the proposed source shall be obtained from the local Water Authority.

SECTION 5 : GENERIC HEALTH, SAFETY AND ENVIRONMENTAL ISSUES

This section covers general health, safety and environmental issues to be considered for the activities, procedures, processes and equipment associated with the use of trenchless techniques.

Emphasis is given to the precautions necessary with particular attention to aspects of site personnel and public safety.

5.1 EMERGENCY PROCEDURES

5.1.1 General

5.1.1.1 Details of the nearest emergency services and contact telephone numbers shall be available on site and displayed in a prominent position.

5.1.1.2 Emergency procedures shall be developed and communicated to all those working on or visiting the site as part of the site induction training.

5.1.2 Fire precautions

5.1.2.1 Assessment of the fire risks on the site should be made and recorded.

5.1.2.2 If required by site conditions, an emergency plan shall be prepared and displayed to indicate each of the following (not necessarily in order of priority):

- means of escape
- action to be taken
- evacuation procedure
- method of calling the fire brigade
- method of raising the alarm.

5.1.2.3 If necessary, there shall be the following:

- liaison with the fire brigade, including arrangements for access
- appropriate means of fire fighting, adequate training and fire drills
- a record kept of fire-related events
- appropriate, maintained fire extinguishers available on site.

5.1.2.4 Checks shall be made to ensure safe disposal of refuse and adequate storage for flammable materials.

5.1.2.5 There shall be an adequate allocation of fire fighting equipment to cover working areas, plant and special risks.

5.1.2.6 Control of materials which are a fire risk or which contribute to the fire loading on site is required to minimise the fire risk. Where possible, flammable materials should be eliminated from the construction process.

5.1.3 Procedures in the event of utility network strike

5.1.3.1 In the event of a utility network being damaged, all machinery shall be stopped and electrical supplies isolated immediately. Providing it is safe to do so, all personnel shall be moved from the immediate vicinity and then the following steps should be taken:

- contact made with the utility network owner

Note: In the event of a gas strike, the gas utility company can be notified by contacting the gas emergency service whose number is 0800 111 999.

- remove all personnel from the vicinity
- inform the supervisor
- enforce "no smoking"
- remove naked flames
- do not attempt repairs unless competent to do so
- assist engineers or emergency services as requested.

5.1.3.2 The competent person managing the site shall ensure the area is secured from persons entering the site until the situation can be made safe.

5.2 WORKFORCE CONSIDERATIONS

5.2.1 Health

The continuing good health of the workforce is of paramount importance. Workplace conditions shall be assessed on a continuous basis to ensure that high standards of health and welfare are maintained and to ensure that work processes are not a risk to the health of the workforce.

Health risks can result from:

- exposure to harmful materials used in the construction process
- exposure to harmful material encountered or released during the construction process
- ergonomic factors resulting from the construction process, for example noise, vibration, manual handling etc.

Note: The current HSWA legislation which relates to monitoring of occupational health in construction is included in Appendix 2.

5.2.2 Welfare

5.2.2.1 Due to the transient nature of trenchless work, the provision of proper welfare facilities can be challenging but must be provided. A suitable fixed or portable sanitary convenience or easy access to publically available toilets, facilities for hand washing or cleaning and a supply of drinking water shall be provided before work starts on site.

5.2.2.2 While it may not always be reasonably practicable to provide fixed messing facilities such as huts, a suitable place for eating and drinking away from the working area, such as a van or other vehicle, shall be provided or designated.

5.2.2.3 Facilities for cleaning, drying and storing bad weather clothing and basic PPE shall also be made available.

5.2.3 Avoidance of accidents

5.2.3.1 Work shall be planned to minimise lengths of cable, pipe, hose, etc in or around pedestrian worker access areas to reduce the risk of slips, trips and falls on site.

Note: General Guidance can be found in HSG150.

5.2.3.2 The control of risk from slips, trips and falls shall be included in training and induction programmes.

Note: The training and induction programme could highlight key risk areas such as:

- *slips on materials or equipment (steel rails, clay soils, etc)*
- *slips on spillages – oils, bentonites, etc.*
- *trips over rubbish, debris, equipment (cables, hoses), poor access or uneven ground*
- *falls into openings, shafts, excavations*
- *materials falling down shafts, manholes into excavations.*

5.2.4 **First aid**

5.2.4.1 A suitable number of qualified personnel must be available to provide first aid assistance on site to anyone who may become ill or injured, in accordance with the requirements of the First Aid at Work Regulations.

5.2.4.2 First aid equipment must be available.

5.2.4.3 Accidents must be recorded in an accident book.

5.2.5 **General**

5.2.5.1 Materials and processes used on site may be a risk to the health of people directly involved in the construction process, and those employed in the maintenance and disposal of any waste materials.

5.2.5.2 The risk assessment for the project should address risks to health from materials and site conditions which may include the following:

- use of material and equipment during construction
- internal pipe contaminants (rust, Naturally Occurring Radioactive Materials (NORM), dust, monoethyleneglycol (MEG), mains treatments)
- biological agents (bacteria and other biological micro-organisms)
- disposal of waste or surplus material
- exposure after disposal, for example at a landfill site
- activities such as maintenance and cleaning.

Note: Asbestos and lead are covered under their own sets of Regulations.

5.2.5.3 Environmental risks should be assessed as part of the project environmental impact assessment carried out in accordance with Town & County Planning (Environmental Impact Assessment) Regulations.

5.2.6 **Site access**

5.2.6.1 Access shall be provided to ensure that all personnel can safely reach their places of work.

5.2.6.2 The site shall be secured to prevent access by unauthorised persons, particularly children, to:

- areas of danger such as excavations or access points, and machinery
- sites which are within public areas or highways.

Safety of the site when left unattended shall be considered as part of the risk assessment.

Note 1: The provision of barriers to satisfy NRSWA may be inadequate to prevent unauthorised access.

Note 2: Further guidance is given in HSG151.

5.2.6.3 If the site has perimeter fencing, it shall be in good condition with gates that can be securely closed.

5.2.6.4 Ladders that are not an integral part of the drilling rig shall be removed at the end of each shift or stored in a position that prevents access by the public.

5.2.7 Control of substances that may be hazardous to health

5.2.7.1 Materials encountered when using trenchless techniques may be a hazard to health. These materials may be used directly in the process, for example soil modifiers or conditioners may be part of the technique, silica may be present (in concrete or rock), toxic ground contaminants or grouts.

Routes of exposure are inhalation, skin contact and ingestion. Materials which are hazardous may result in an acute reaction i.e. the effect occurs quickly, or it may result in a chronic condition that is one which may take many years to develop.

Hazardous materials have a Workplace Exposure Limit (WEL). These limits are given in HSEH40. They are expressed as either long-term exposure limit (LTEL) or short term exposure limit (STEL).

The LTEL is an exposure level set at a point that (based on current scientific knowledge) will not damage the health of workers exposed to it on a day to day basis.

The STEL is a limit set for substances which may cause the most serious health effects and for which "safe" levels cannot be determined, or for substances for which safe levels may exist but control to those levels is not reasonably practicable.

These set the standards for controlling the exposure of workers to the specified substances.

5.2.7.2 Only if they are dangerous should materials currently supplied to contractors be delivered with a Safety Data Sheet, as required by the Chemicals (Hazard Information and Packaging for Supply) Regulations.

5.2.7.3 The Safety Data Sheet should provide the user with details of the materials and hazards associated with them together with general advice on controls. However, it is often the case that appropriate information is lacking. Usually physical hazards are not included and the control measures given are often limited to the level of PPE that is required to control the risk.

Note 1: It is the suppliers responsibility to ensure that the information on the Safety Data Sheet is accurate. If material is supplied onwards after being used in a newly manufactured material, the supplier of the new material inherits this responsibility.

Note 2: Guidance on the law covering preparation and supply of Safety Data Sheets is contained in HSL130.

5.2.7.4 Hazardous substances must not be allowed on site unless they are in correctly-labelled packaging; a data sheet has been provided and an appropriate COSHH assessment has been carried out. Control measures must be implemented to control the risks identified in the COSHH assessment.

5.2.7.5 Trenchless technology may involve the use of chemicals or substances that could enter the body through the skin, through ingestion or inhalation, or could damage or irritate skin, eyes, ears, etc. The main risk substances that shall be considered are those that fall into the following groups:

- carcinogens
- toxic agents
- neurotoxins
- irritants
- corrosives
- sensitizers.

On any trenchless operation, some of the following substances could be found:

- acetylene
- propane
- aerosols
- antifreeze
- battery acid
- bleach
- hand cleaners
- drilling fluids
- fire extinguishers
- greases oils, cooling, lubricating and hydraulic
- paints
- biological agents.

This list is not exhaustive, but COSHH assessments must be carried out and the relevant information sheets made available to the operatives involved at all times. The major substances in use in quantity are discussed later.

5.2.8 **Fuels and oils for the operation of powered plant**

5.2.8.1 Fuels include:

- petrol
- red and white diesel
- hydraulic oil
- engine oil.

Reference should be made to the manufacturer's literature for COSHH details.

5.2.8.2 Lubricants include:

- standard grease
- pipe joint compound
- lead-free rod grease.

Reference should be made to the manufacturer's literature for COSHH details.

5.2.8.3 Soil lubricants and stabilisers that shall be considered include:

- sodium montmorrillonite
- calcium montmorrillonite
- polymers
- powders
- granular.

5.2.8.4 Although usually a low risk, care shall be taken when using powders. Due to the fine texture of the powder, eye protection and respirators should be worn when handling large quantities. Wet spillage should be treated carefully due to the high degree of slip. Light gloves should be worn if the product requires manual handling.

Reference should be made to the manufacturer's literature for COSHH details. For details of general hazards associated with soil conditioners, reference should be made to Appendix 4 or to BS 6164.

5.2.9 **Polymers as drilling fluids and as an additive to bentonite**

5.2.9.1 Polymers as drilling fluids and as an additive to bentonite include:

- liquid
- dry powder
- granular.

Most polymer drilling fluids are environmentally safe and bio-degradable. No special handling is required due to the low toxicity and low hazard potential. However, it should be recognised that polymer spills could present a slip hazard.

5.2.9.2 Dry polymer spills should be swept up immediately. Wet spills should be treated with an absorbent material and then swept up. Disposal of discarded waste material must follow applicable disposal regulations.

5.2.9.3 Light gloves should be worn if the product requires manual handling.

5.2.10 **Grouts and drilling fluid thinners**

These products are chemically similar to, and shall be treated the same as, standard bentonite.

5.2.11 **Resins used in lining techniques**

5.2.11.1 Reference should be made to the manufacturer's Safety Data Sheets to ensure that any risks associated with the use of resins have been identified to protect both operatives and the general public.

5.2.11.2 A risk assessment must be carried out for all work activities to comply with the requirements of MHSWR.

5.2.11.3 Where material health hazards are identified, a risk assessment complying with COSHH must also be carried out.

The risk assessment shall identify health hazards as well as the more commonly recognised safety hazards. These need to include all operations in the construction cycle during which employees may be exposed to the material. As part of the risk assessment, it is necessary to identify the materials which present a hazard. These may be identified from various sources including information provided by the manufacturer or supplier of the material.

5.2.12 **Manual handling**

Wherever possible, mechanical means should be used to lift, transport and move items otherwise, manual handling methods should be arranged to take account of the size, weight and shape of the load.

Note 1: Guidance on maximum weights and lift distances is given in HSL23.

Note 2: Guidance on manual handling in the construction industry is given in HSG149.

5.2.13 **Noise**

5.1.13.1 A certain amount of noise is inherent in all construction operations. The best practicable methods shall be employed to minimise noise emissions to levels acceptable to site personnel and third parties and must be employed sufficiently so as to comply with regulations.

Note: Further advice is contained in HSL108.

5.2.13.2 Special consideration shall be given to:

- designing out noise-generating operations before construction starts
- siting and possible screening of plant and equipment
- use of acoustically-attenuated powered tools
- avoiding operations outside normal working hours.

5.2.14 **Vibration**

5.2.14.1 Regular exposure to hand-arm vibration can cause a range of permanent injuries, collectively known as HAVS which is a notifiable occupational disease. Health surveillance must be provided where there is a risk of HAVS, in compliance with MHSWR and the Control of Vibration at Work Regulations. HSE Guidance is available for controlling risk to health due to hand-arm vibration (see Appendix 2).

5.2.14.2 Action must be taken to control exposure and prevent adverse health effects. If the HSE recommended action level of 2.8 m s^{-2} is exceeded, a programme of health surveillance must be formed to identify new cases of HAVS and to ensure that existing cases do not become more severe.

5.2.14.3 A risk assessment must be undertaken to identify any risks of HAVS and appropriate actions taken to control the risk to eliminate or reduce exposure to vibration. Consideration shall be given to the following:

- changing processes or working methods

  Note: Selection of "low vibration" tools and equipment can often prevent unnecessary high exposures and equipment suppliers can provide information and advice.

- training for personnel on the risks from vibration to allow them to operate equipment so that risk is minimised.

5.2.15 **Health surveillance**

5.2.15.1 The occupational health of workers shall be monitored on a regular basis.

5.2.15.2 Early medical advice should be obtained in relation to any health problem or injury that may be affected by work.

5.2.15.3 Where the risk assessment identifies high risk to health of workers as part of the work process, a medical surveillance programme should be set up.

5.2.15.4 Formal health surveillance shall be carried out in certain circumstances where risk to health is judged to be high.

5.2.15.5 The main legislation requiring health surveillance is set out in Appendix 2.

5.2.15.6 A RIDDOR notification must be made where a diagnosed disease as specified in Schedule 3 of the Regulations is identified, for example, Hand-arm vibration syndrome (HAVS), the most common form of which is Vibration White Finger (VWF).

5.3 **PUBLIC SAFETY**

5.3.1 **General**

5.3.1.1 Hazards to the public shall be identified as part of the site risk assessment. Risks resulting from hazards identified should be controlled to prevent harm.

5.3.1.2 Where work is to be carried out within the public highway, the requirements of NRSWA must be applied, including and in particular, those defined within the

associated CoPs (see clause 3.2.5.2).

5.3.1.3 Plant shall be immobilised at the end of every shift.

5.3.1.4 All statutory notices concerning safety of the public must be clearly displayed where the public can view them.

5.3.1.5 Parking of vehicles associated with works shall not present a hazard to the public.

5.3.1.6 Extreme care shall be taken to ensure that any public right of way affected by the works is kept safe and free of any hazard. Special consideration shall be given to disabled persons and those with impaired mobility, vision, hearing, etc.

5.3.1.7 Any walkways, including stairs, ramps, roadways and paths, must be kept free from obstruction.

5.3.1.8 Visitors to the site are in greater potential danger than operations personnel. They should be kept away from operational areas unless the nature of their visit demands otherwise. If necessary, operations shall be suspended until visitors are moved to a safer position.

5.3.1.9 All persons visiting the site shall be given safety induction training, be issued with appropriate PPE prior to entering the site and, if a risk assessment deems it necessary, the operation shall be suspended.

5.3.1.10 All visitors to site shall sign a visitors book kept on site for that purpose, where appropriate.

5.3.1.11 Public access shall be defined clearly and signposted taking into account all disability groups. Special consideration shall be given to catering for unaccompanied children and persons with impaired mobility, vision and hearing.

5.3.2 Equipment and materials

5.3.2.1 Hazardous materials used on the site shall be stored safely. Particular attention shall be paid to the storage of flammable materials which shall be stored in accordance with HSG51.

Note: Further guidance is given in UKLPG CoP 24.

5.3.2.2 Attention shall be given to the siting and laying of umbilical cables and hoses.

5.3.2.3 Edge protection shall be provided where anyone could fall and, where practicable, toe boards shall be fitted.

5.3.2.4 Material stacks, including drill rods and debris, shall be kept tidy and in a safe position.

5.3.2.5 Rubbish and waste materials, including excess drilling fluids used during the drilling process, shall be cleared and removed at regular intervals.

5.3.2.6 Nails in timber used for pit shuttering shall be removed or hammered over.

5.4 ELECTRICAL SAFETY

5.4.1 Electrical cable strike safety system

Despite the most rigorous of pre-site surveys, a risk remains, in all trenchless techniques, of accidental damage being caused to buried electrical cables.

Note: Electricity companies bury cables of all voltage ratings between 240V and 400kV.

Depths and protection of electrical cables are variable and should be confirmed with the local electricity supplier.

5.4.2 **Explosion protection of electrical equipment**

For non-domestic premises, DSEAR require that a risk assessment be carried out and, as part of this, a hazardous area assessment must be undertaken. If such a hazardous area assessment has not been undertaken prior to the intended work involving electrical equipment, a risk assessment must be carried out to determine the likelihood of explosive gases being present and an explosion protection document must be made available to the user. This should lead to the selection of appropriate equipment for use in the expected conditions.

5.4.3 **Work on or with electrical equipment**

When carrying out work activities on or with electrical equipment, the work must comply with the Electricity at Work Regulations (see Sub-Section 3.3.6).

5.5 LIFTING APPLIANCES AND EQUIPMENT

5.5.1 All lifting appliances, equipment and lifting operations must be in accordance with LOLER and HSL113. Any lifting operation must be planned and supervised by a competent person.

5.5.2 A risk assessment shall be carried out to identify and assess the risks associated with the lifting operation.

5.5.3 Mechanical lifting is preferred. However, if manual handling is used, consideration shall be given to safe working practice to prevent injury. Guidance is given in clause 5.2.12.

5.5.4 A method statement should be prepared prior to any lifting operation and consideration shall be given to proximity hazards such as overhead cables, soft ground or underground services.

5.5.5 Lifting operations crossing live gas, water or electrical equipment present a risk to health and safety in the event of a load being dropped. If re-planning the operation cannot eliminate the risk, the method statement, including safe working procedures, shall include a contingency plan to cover the occurrence of an incident during the lifting operation.

5.5.6 Lifting equipment must be marked and examined in accordance with LOLER.

5.5.7 Lifting equipment shall be thoroughly examined in accordance with a scheme of inspection determined by a competent person. Appropriate inspection and test certificates shall be available for inspection prior to use.

5.5.8 All lifting equipment shall only be operated by personnel who are competent, certificated and authorised.

5.5.9 If the driver's view is restricted, a banksman with appropriate means of communication to guide the driver must always be used.

5.5.10 Slinging and banksmen duties shall be carried out by trained, authorised slingers/banksmen.

5.5.11 Safe working loads (SWL) of equipment must not be exceeded.

5.5.12 Practical steps must be taken to prevent falling or spillage of materials.

5.5.13 Appropriate signs and barriers shall be used to:

- mark any identified hazard
- provide a warning about the lifting operations
- prevent access to areas subject to risk from the lifting operations.

5.6 MAINTENANCE OF PLANT, MACHINERY AND POWER TOOLS

5.6.1 General

5.6.1.1 All equipment shall be maintained in accordance with manufacturer's instructions. The responsible person shall ensure that it has been regularly serviced, maintained and checked in accordance with the manufacturer's instructions.

Note: The service/maintenance history can be requested at the time of placing your order for the provision of the drilling rig. In respect of daily/weekly checks these can be either observed by the competent person and/or checking any documentation used for that purpose. This applies to any associated equipment, such as the drill head tracker, any lifting equipment, etc. that may be used during the HDD operation including support vehicles.

The requirements of both PUWER and LOLER must be observed.

5.6.1.2 Guards covering moving parts shall be maintained at all times.

5.6.1.3 Where applicable, hand tools should be kept sharp and in good serviceable condition.

5.6.1.4 Power tools shall be inspected before use and maintained at regular intervals.

5.6.1.5 Where necessary, training shall be given and certificates issued, particularly in respect of abrasive tools and welding equipment.

5.6.1.6 Where possible, electrical equipment should be run off a portable, centre tapped to earth, 110V transformer circuit. Any 240V fixed-installation circuits shall be protected by residual current circuit breakers.

The installation should conform to BS EN 60204.

5.6.1.7 Care shall be taken where electrical equipment may be exposed to bad weather conditions or mechanical damage.

5.6.1.8 Electrical equipment on site shall be subject to regular inspection and testing.

5.6.1.9 Electrical safety clothing shall be tested to manufacturer's instructions.

5.6.1.10 Records should be kept of all tests and inspections.

5.6.1.11 Where required, PPE shall be supplied and maintained

Note: Examples include helmets, gloves, goggles, masks, overalls, boots, etc. (see Sub-Section 5.10).

5.6.2 Equipment conformity

5.6.2.1 All new machinery should be CE marked and the manufacturer should issue a Declaration of Conformity for the machine. The manufacturer shall provide instructions to explain how to install, use and maintain the machinery.

If applicable, the machinery shall display the following warning notices:

- carrying compressed air
- carrying oil mist.

5.6.2.1 A CE mark is not a guarantee of safety; it is a claim by the manufacturer it complies with the Supply of Machinery (Safety) Regulations. The machine must comply with the Essential Health and Safety Requirements (EHSRs) of the supply law. A machine that has been made to a recognised standard does not guarantee conformity with the relevant EHSRs. Employers shall still need to check the machinery is safe to use.

5.6.3 Pneumatic and hydraulic equipment

5.6.3.1 *General*

5.6.3.1.1 Any fluid under pressure is potentially dangerous and capable of penetrating the bloodstream. Eye protection shall be worn at all times. Any pressure within air or fluid pressure hoses shall be proved to have decayed before breaking a joint.

Note: This is especially important when breaking rods during the drilling or pull-back operation.

5.6.3.1.2 Hoses used for water, mud, pneumatics and hydraulics should be certificated, inspected at frequent intervals for damage and wear, shall comply with the relevant BS EN and ISO Standards for hoses and be marked for conductivity.

Steel-reinforced hoses shall be bonded to earth and high pressure hose joints shall be fitted with longitudinal restraints, anchored securely at each end to prevent whiplash in a failure situation.

Note: The following Standards are relevant:

- *BS EN 982 (for hydraulics)*
- *BS EN 983 (for pneumatics).*

5.6.3.2 *Drilling and the use of compressors and compressed air*

5.6.3.2.1 Compressors shall be set up on level ground so that internal lubrication will not be affected adversely and correct loading will be applied to bearings. The parking brake shall be applied and/or the wheels chocked to prevent vibration moving the unit.

5.6.3.2.2 Pre-start, daily checks shall be made on oil, fuel and coolant levels, and on the condition of air cleaners.

5.6.3.2.3 A daily check shall be made of the condition of all hoses, clips, couplings and restraints. Before starting, all connected equipment shall be in the off position and all operating controls shall be in neutral.

5.6.3.2.4 Connected equipment should be fitted with an air pressure gauge and a main air shut-off, excess flow or cut off valve, so that the effects of a burst are minimised.

5.6.3.2.5 Air supply hoses shall be suitable for the working pressure and hose ends and fittings should be of the correct size and type.

5.6.3.2.6 Air hoses shall be fitted with longitudinal restraints anchored securely at each end to afford protection.

5.6.3.2.7 Air exhausts and air lines being blown out shall be directed away from site personnel.

5.6.3.2.8 Compressed air shall not be used for cleaning out storage drums or cleaning down the rig and equipment, unless the air line includes the correct end fittings and valves.

5.6.3.2.9 Compressed air shall not be used to clean the skin or to clean dirt from clothing, as this could cause serious injury or death by embolism in the blood system.

5.6.3.2.10 Air leaks shall not be located with bare hands.

5.6.3.2.11 Damaged, frayed or deteriorated hose shall not be used.

5.6.3.2.12 Hoses shall be stored properly after use, away from heat sources or sunlight.

5.6.3.2.13 Air supplies shall not be shut off by kinking or bending of the hose.

5.6.3.2.14 All compressed air shall be released safely before any work is carried out on compressor or work equipment.

5.6.3.2.15 Air receivers shall be marked clearly with the safe working pressure/safe operating limit and shall be fitted with a pressure gauge.

5.6.3.3 *Hydraulic installations*

5.6.3.3.1 Hydraulic pipes, hoses and fittings shall be marked clearly with the rated working pressure. They shall meet the requirements of BS EN 982 and BS EN 983.

5.6.3.3.2 Where a hydraulic hose could burst adjacent to operators, the hose in this area shall be guarded in accordance with BS EN ISO 3457.

5.6.3.3.3 Flexible hydraulic hoses intended for use at a pressure higher than 150 bar (2175 psi) shall be fitted with swaged end fittings.

5.6.3.3.4 Pipes and hydraulic hoses that could be disconnected in operation shall be fitted with self-sealing couplings with built-in check valves. Couplings should be marked to ensure correct re-coupling after disconnection.

5.6.3.3.5 Hydraulic hoses and pipes shall be separated from electrical wiring and be protected from hot surfaces and sharp edges.

5.6.3.3.6 Hydraulic fluids used shall be non-toxic and, if there is a risk of fire, consideration shall be given to using fire resistant hydraulic fluid.

5.6.3.3.7 Generally, hydraulic systems shall comply with the requirements of BS EN ISO 12100 and BS EN 982.

5.6.3.3.8 Effective contamination control measures shall be in place.

5.6.3.3.9 Any fluid leak shall be rectified immediately.

5.6.3.3.10 Fluid levels shall be checked regularly and topped up if necessary. Any manufacturer's stated relief valve settings shall not be exceeded.

5.6.3.3.11 The correct grade of hydraulic fluid shall be used.

5.7 GAS MONITORING

5.7.1 Toxic and flammable gases can be present from a variety of sources. Some of these are naturally occurring and some are man-made. The following lists common gases. However, the list shall not be considered comprehensive and further advice should be sought, if necessary, to identify the presence of any other gas that may be a threat to health or safety. For reference, short and long term occupational exposure standards are given in HSEH40:

- methane - naturally occurring from coal measures, or from man-made sources such as gas pipelines, landfill sites, sewers, etc.
- carbon monoxide - can result from blasting fume or vehicle exhaust emissions and is highly toxic
- oxides of nitrogen - can result from blasting fume or vehicle exhaust emissions and are highly toxic
- carbon dioxide - can result from blasting fume or vehicle exhaust emissions or from the reaction of acidic groundwater on carbonate rock such as limestone. Asphyxiant at high concentrations
- sulphur dioxide - from vehicle exhaust emissions
- hydrogen sulphide - from sewers or the action of sea water on sewage. Highly toxic with a distinctive smell, however it dulls the olfactory nerves reducing the sense of smell
- radon - naturally occurring radioactive gas
- ammonia - from chemical grouting, blasting fume and, possibly, the action of cementitious grout on organic silts
- diesel engine exhaust emissions contain a range of toxic or carcinogenic compounds such as aldehydes and also particulates
- volatile organic compounds, for example toluene, xylene and benzene, from former industrial processes such as steel manufacturing or tar making. They are carcinogenic but can also give rise to a significant risk of explosion due to their relatively low explosive limits
- organic solvents resulting from leakage from industrial premises. Frequently toxic or carcinogenic
- hydrocarbon gases occur due to leakage into the ground from petrol and oil storage tanks.

5.7.2 Oxygen should be monitored.

Note: A high or low oxygen concentration can be a risk to health due to oxygen deficiency (possibly associated with the presence of other toxic gases) or oxygen toxicity due to increased oxygen concentration. Increased oxygen concentration leads to increased fire risk.

Other gases identified in the risk assessment shall be monitored.

5.7.3 Continuous monitoring should be carried out at all locations, as defined within the risk assessment, to ensure that effective detection and monitoring of gases with different characteristics is achieved.

5.7.4 Gas monitoring equipment shall be serviced and calibrated in accordance with the manufacturer's instructions.

5.7.5 Records of routine monitoring should be kept, irrespective of the results obtained. Abnormal events should be recorded and reported.

5.7.6 Emergency procedures shall be drawn up to deal with foreseeable alarm conditions.

Note: These may include one or more action levels.

5.8 EXCAVATIONS AND EARTHWORKS

5.8.1 The Highways Authority should be consulted at an early stage in the preliminary investigations for a trench to be excavated in a highway. Where the public has access to an excavation, the site has to be adequately fenced, guarded and lighted so as to give proper warning to the public during the hours of darkness.

Traffic signs shall be placed, operated and lighted in accordance with the Code of Practice, Safety at Street Works and Road Works, issued under NRSWA.

Note: Legislation that may affect the excavation of trenches on a highway include The Highways Act, NRSWA and the Traffic Management Act.

5.8.2 A general appraisal of the project and a site investigation should be undertaken.

5.8.3 Knowledge of the ground conditions and land surface features gained from the site investigation should be used to determine:

- the appropriate method of excavation and related plant requirements
- the appropriate form of support to the sides of the excavation and to ensure its adequacy.
- suitable means of maintaining the excavations free from ground water.

5.8.4 Excavations in non-cohesive soils, such as sands, present problems of confinement. Granular soils readily collapse so they should be cut back to a suitable slope or in a restrained position using continuous sheeting.

Note: Excavations in cohesive soils, such as sandy and silty clays generally present little problem of confinement. Principal problems are those of stability in the short and medium term, whether of a vertical-faced excavation or of side slopes.

5.8.5 The clearance between the toe of the spoil heap and the edge of the excavation should give sufficient working space at all times and a minimum width of 0.3 m should be provided.

Note: It may be possible to rely on the stability of an unsupported vertical face of a trench excavation less than 1.2 m deep, where precautions are taken against overloading the ground surface close to the edge of the trench and against risks to operatives from local falls.

5.8.6 A test for gases should be carried out when excavating on domestic or industrial wastes containing toxic or asphyxiating compounds or gases that can be hazardous to operatives.

5.8.7 Operatives should be aware that, irrespective of what method of excavation is used, ground displacements occur both within and immediately surrounding an excavation.

Note: Vibrations from bursting equipment may cause consolidation of cohesionless soils or have a detrimental effect on existing structures in a weak condition.

5.8.8 In certain instances, such as work on deep sewers, deep excavations may be required. Where trenches or pits are excavated deeper than 1.2 m, they should be supported if personnel are required to enter them.

Conditions should be regarded as unstable even in firm and stiff clays and in fissured and closely-jointed rocks.

Lateral supports for any part of an excavation should not be altered or dismantled except under the direction of a competent person possessing adequate experience.

5.8.9 The design and position of excavations should take into account the prior location and safe support of all services such as sewers and water and gas mains that may run parallel to the proposed works, and of any buried structures such as underground tunnels that may be affected by excavations in very close proximity.

5.8.10 All supported excavations should be provided with guard rails, hand rails, staging and ladders, as may be required to protect operatives working within or around the excavation, and the passing public.

Where appropriate, stop blocks should be used to stop vehicles endangering the excavation.

5.9 OPERATIONS IN CONFINED SPACES

5.9.1 Any operation involving a confined space must comply with the Confined Spaces Regulations and HSL101.

5.9.2 Competent supervision shall be available on site and a safe system of work specified.

5.9.3 An assessment of the work shall be made and, if necessary, method statements shall be available on site. Where appropriate, permits to work should be obtained and signed. Further guidance is given in IGEM/GL/6.

5.9.4 Appropriate protective clothing and safety equipment shall be provided and available, according to need.

5.9.5 Persons shall not work alone.

5.9.6 Warning notices and lock-off devices shall be checked.

5.9.7 An adequate communications system shall be established between those inside and those outside any confined space.

5.9.8 Where adequate quality of air by natural or forced ventilation cannot be guaranteed, the operation shall be suspended.

5.10 PROTECTIVE CLOTHING

5.10.1 The choice and provision of PPE must be in compliance with the Personal Protective Equipment at Work Regulations and the detailed method statement.

5.10.2 At all times, the correct attire for the site and weather conditions shall be worn.

5.10.3 It should be ensured that the crew have the correct protective clothing and that this is worn as required.

Note: For certain operations, special clothing is required, for example when working with electricity, on water courses, etc.

5.10.4 All operatives shall wear standard site equipment, as appropriate, such as:

- gloves
- toe protector boots/shoes
- safety helmet
- overalls
- high visibility jacket.

5.10.5 Ear protection and eye protection shall be available, if required, during the process.

Wet weather suits should be of good quality.

Clothing should have the minimum of flaps and protrusions.

5.10.6 Substantial gloves should be worn when handling any reamers, rods etc.

Hand protector gloves should be used when dealing with any drilling fluids, grease, oils, etc.

Anti-vibration gloves should be used when operating vibrating equipment.

5.10.7 Where flammable gaseous atmospheres may be encountered, breathing apparatus shall be available and worn where risk assessment requires.

Flame retardant clothing shall, be worn and, where risk assessment requires, fire protective clothing such as fire suit, flash hood and gloves shall be worn.

SECTION 6 : RISK ASSESSMENT

Risk assessment is an essential element in the management of health, safety and the environment. It is needed to ensure compliance with the requirements of health and safety legislation, as outlined in Section 3. The main purpose of risk assessment is to identify the risk relating to a particular activity. Subsequently, the risk can be reduced to an acceptable level.

Note: Appendix 4 provides an example of a risk assessment.

The majority of risk assessments are not complex in nature and may be undertaken by personnel who have practical knowledge and experience of the work activity. However, specialist advice from a health, safety and environmental professional or expert may be required for unfamiliar hazards or where special measurements are required.

Current Regulations impose a duty upon employers to make a suitable and sufficient assessment of:

- the risks to the health and safety of their employees to which they are exposed while they are at work and
- the risks to the health and safety of persons not in their employment arising out of, or in connection with, the conduct by them in their undertaking
- risks to the environment from the activities to be undertaken during the project.

Furthermore, all companies employing more than five people are required to document Safety Assessment Records for distribution to all employees. Each company should conduct its own safety assessment and produce associated documentation for distribution to its employees.

Note: IGE/SR/24 provides guidance on such assessments. IGEM/GL/4 gives advice on risk management of gas assets.

The following requirements assist in carrying out risk assessment. There will be significant differences between the methods of operation of different companies and between the different techniques. Therefore, these requirements address general issues only. Individual companies need to concentrate their effort on those areas of their operations where they perceive that the greatest potential hazards exist.

6.1 SAFE WORKPLACE, SAFE PERSONS AND SAFE SYSTEMS OF WORK

6.1.1 General

The measures and procedures to reduce the possibility of an accident should meet the overall objective of any company safety plan. The three prime objectives shall be to:

- to create a safe workplace
- to encourage each employee to be a safe person
- to employ safe systems of work.

6.1.2 Safe workplace

A safe workplace is made possible only by a concerted effort by all concerned in the company. Both the company and employee have a shared responsibility to remove, or reduce as far as reasonably practicable, any danger that may exist. The company must ensure that any equipment meets the requirements of the design and of statutory regulations and supply any PPE necessary. In addition, safety training must be made available for all employees.

6.1.3 Safe persons

Safe persons are those who recognise a responsibility to guard themselves and others from risk. Such persons should be appropriately trained such that they

can identify hazards and take suitable actions to minimise risk of exposure to such hazards. If the control of the hazard is beyond their capability to deal with, they should report it to the appropriate person as requiring attention. Drilling and moling technicians shall be formally qualified, with evidence of Certification.

6.1.4 Safe systems of work

Any employer must ensure that machinery and its associated equipment, selected for a specific operation, is suitable for the intended use taking into account site, operational and environmental conditions. A training program in the safe operation of each type of rig and work system must be provided and updated as necessary.

SECTION 7 : SITE OPERATIONS

This section covers operational activities and potential known hazards. Operational procedures shall be established prior to commencement of work.

7.1 SITE OPERATIONAL PLAN

7.1.1 General

7.1.1.1 A detailed pre-tender Safety Plan shall have been established at the project planning stage (see Section 4). However, a high level of communication should be maintained at all times between any trenchless operation and the other project site activities.

7.1.1.2 An emergency contact list shall be established containing details of personnel associated with the works, their contact telephone numbers and details of local emergency services with contact numbers where appropriate (See Clause 5.1.1).

7.1.1.3 The project proposal documentation, submitted to operational staff and operatives, shall be effectively communicated to those personnel engaged on the project. Operational personnel shall verify and satisfy themselves that all documentation prepared by the designer meets with the requirements listed in the management procedure and is understood. This should include, as a minimum, the following:

- health, safety and environmental plan, including method statements
- copies of all underground services and structures plans
- protection information from owners/operators of underground services and structures and land owners where applicable.

7.1.2 Location of buried services

7.1.2.1 Utilities' plant shall be assumed to be present. Any service encountered should be considered to be live.

Underground utilities, are potentially hazardous for example damage to:

- electricity cables can cause a dangerous flash leading to severe burns or even death
- gas and oil pipelines can increase the risk of fire or explosion

Note: Effects can travel considerable distances underground.

- water mains could lead to trench collapse, blast injury and drowning
- pumping sewers would be a biological hazard
- fibre optics (lasers) could potentially lead to eye damage.

Guidance on locating underground services is given in HSG47.

7.1.2.2 A safe system of work (See clause 6.1.4) shall be adopted when identifying the location of buried services and underground structures. This consists of a four-tier approach:

- planning the work
- plans and information
- cable and pipe location devices
- safe digging practice.

Each of the above complement the other and all four shall be used when working near underground services. Guidance from the owners of buried services and structures shall be followed, to prevent damage.

7.1.2.3 Accidents can occur as a result of confusion caused by the appearance of a service. For example, a black plastic-covered electricity cable could be mistaken for a black plastic water pipe and cast iron gas and water mains appear similar. Consequently, before work is commenced, measures shall be taken as follows:

- obtain plans of the underground services in the area

  Note: *"service connection cables and pipes" from the main to the building or street light may not be shown on a plan.*

- invite the utility companies to the site to confirm the presence or otherwise of their plant and explain the planned method of installation
- use a cable and pipe locator/underground mapping system, which is operated only by trained personnel, to trace the location of all underground utilities. Consider the use of equipment capable of detecting any form of underground plant or utility, specifically non-metallic plant and obstacles, for example ground probing radar (GPR) scanner
- mark the position, including depth where possible, of the cable and pipe, using paint or other waterproof marking on the ground or using nonconductive label pegs in soft ground
- look for signs of service connections in the form of cable, duct or pipe for electricity, gas, water etc., in particular a service connection entry into a house or street light
- obtain plans of foul and surface water sewers from the relevant utility or highway authority. If in doubt about the sufficiency and/or accuracy of the information, seek their advice and assistance in determining a safe system of establishing the actual locations and depths
- do not lift manhole covers without first seeking permission of the relevant authority and never allow entry into a manhole or chamber unless the necessary trained personnel and safe systems of work are in place as required by the Confined Spaces Regulations
- confirm the position and depth of existing plant by hand excavated trial hole, where appropriate
- use safe hand digging practices when exposing buried services (spades and shovels are safer than picks, pins or forks)
- remember that cables could be embedded in concrete. Electricity cables embedded in concrete should either be made dead before the concrete is broken out or another safe way of working agreed with the cable owner
- do not remove concrete thrust blocks associated with gas or water mains.

7.1.2.4 If any underground plant is damaged, the emergency procedures required under Sub-Section 5.1.3 shall be followed.

7.1.3 Use of laser survey equipment

The manufacturer's guidance on the safe use of laser survey equipment shall be observed.

7.2 SITE OPERATIONAL PROCEDURES

7.2.1 Information, instruction, roles and responsibilities

7.2.1.1 Everyone involved in trenchless activities, including those designing systems and those managing an installation, shall be competent to carry out the work as follows:

- designers shall have a knowledge of the technique to confirm it is the most appropriate method to be used
- managers shall have an appreciation of the equipment and techniques employed and should understand the limitations of the technique
- supervisors shall have detailed knowledge and be competent in the mode of operation, maintenance and the appropriateness of the task to be undertaken

  Note: It is not necessary for supervisors to be competent in using the equipment.

- operators shall have undergone suitable training in the use of the equipment and plant location, and interpretation of plans, when undertaking the activity.

If being trained, persons shall be supervised by a competent person.

Note: Further information on training and accreditation is given in Section 9.

7.2.2 **Health and Safety**

Due regard shall be paid to the following requirements and those in Section 5 to protect operatives against potential hazards. Operatives shall be made aware of the potential hazards associated with the activity. The competent person must inform the responsible manager in the event of any incident occurring.

7.2.2.1 *Equipment selection*

7.2.2.1.1 When selecting equipment, due consideration shall be taken of the ground conditions where it is to be used as the performance of equipment can be affected by certain conditions.

7.2.2.1.2 The size and type of equipment should be selected:

- which will suit the pipe being inserted
- taking into account a possible average bore shrinkage of 10% that may occur with each size of soil displacement machine.

7.2.2.2 *Suitability of the chosen technique as an installation process*

The following shall be considered:

- suitability of ground conditions
- equipment suitability
- location of other plant, structures
- public safety.

7.2.2.3 *Equipment stability*

Equipment shall be monitored for stability at:

- set up
- start up
- operation
- breakdown
- removal.

7.2.2.4 *Equipment condition*

All equipment shall be inspected and deemed satisfactory before use.

7.2.2.5 *Permitry*

Contractors and sub-contractors shall have their own risk assessments and evidence of these shall be produced.

The control measures identified shall include the requirement for a "Permit to Drill" (see Appendix 7).

Where a specific hazard is identified in the operational risk assessment, a safe system of work shall be required. This shall consist of a risk assessment and a method of work that minimises the risks and provides adequate controls. For instance, disturbance of tree roots shall be minimised.

Note 1: Certain operations identified in the risk assessment, safe method of work or the site-specific risk assessment may identify the need for all or part of the operation to be controlled by a permit to work system, for example, work near a pipeline or deep excavation.

Note 2: For avoidance of tree roots additional guidance is given in NJUG Volume 4.

7.2.2.6 *Protective clothing*

7.2.2.6.1 Protective measures should be in place to safeguard operatives against the potential effects of clothing that may become contaminated with oil or waste products.

7.2.2.6.2 Boots and gloves with a 20 kV rating shall be worn.

7.2.2.6.3 When filling a lubricator, nitrile gloves and eye protection shall be worn.

7.2.2.6.4 A minimum of one layer of fire retardant clothing shall be worn.

7.2.2.6.5 Dust masks shall be worn to protect against inhaling oil mist particles from the exhaust.

7.2.2.6.6 Head protection shall be worn. Ear and eye protection shall be worn as appropriate for the chosen technique.

7.2.2.6.7 Breathing apparatus shall be present and ready for use.

7.2.2.7 *Electrical*

Due to the risk of electrocution, operatives shall:

- not come into contact with cables
- use electrical earthing mats when in contact with drilling equipment if the strike alarm is triggered, remain on the mat and contact the electricity company
- ensure hoses are non-conductive
- for moling, exit excavation and report to the electricity company if cables become damaged
- locate and plan to avoid contact with overhead cables and power lines when carrying out lifting operations
- fit machines with cable strike alarm as appropriate.

Reference shall also be made to Section 5.4.

7.2.2.8 *Excavations and earthworks*

Where the activity involves deep excavations, appropriate fall protection with effective signing lighting and guarding shall be used.

7.3 Horizontal Directional Drilling (HDD)

7.3.1 General

7.3.1.1 HDD is a complex operation and personnel involved operationally, whether managing or carrying out this activity, need to be trained. Persons undertaking the management and supervision of HDD operations require evidence of competency.

Note: For example, City and Guilds 5831 Utilities Operations Scheme or other schemes, which may be developed and approved, can provide this.

In addition to training on the HDD technique, operators will be expected to have undertaken training on the use of the particular machine they are using

7.3.1.2 HDD operations require several people to have the following key roles:

- employer
- designer(s)
- manager
- drill rig operative
- authorising engineer
- responsible person
- competent person

Note: One person cannot simultaneously fulfil the roles of Responsible Person and Competent Person for the same operation, these individuals need to be clearly identified on documentation.

These roles should be identified within the employer's permitry system, for example Safe Control of Operations.

7.3.1.3 For the majority of pipes installed using HDD, the processes in this Sub-Section will apply. However, where special engineering difficulties arise, more investigation work will be required to be undertaken at the planning design stage (see Sub-Section 4.4.5). This investigation shall be carried out by individuals with the necessary competence.

7.3.1.4 Some of the major potential risks associated with HDD operations are listed below. The competent person shall inform their line manager in the event of any of the following occurring:

- failure to complete the bore or pullback operation successfully
- injury to any worker or member of the public
- degradation of environmental, natural, historical or cultural resource
- collapse or subsidence of the surface or adjacent underground plant
- heaving or humping of the surface or damage to structure or roadways
- inadvertent fluid returns
- striking existing underground plant
- significant deviation from the proposed drill path profile.

7.3.1.5 There are a number of instances where relevant authorities will not allow HDD unless agreed. These relate to certain types of locations, premises, underground services, structures, etc., along the proposed route. Although not exhaustive, the following list indicates some situations where the use of HDD may not be appropriate and shall be considered:

- inside or within 10 m of the boundaries of gasholder stations, above ground installations and pressure regulating installations (PRIs)

- within 10 m of the known location of National Transmission and other transmission pipelines
- within the specified distance dictated by the owners/operators of 3rd Party Pipelines
- within 10 m of oil cooled electric cables and electric stations/sub-stations where their underground plant exits
- within terraced streets that contain cellars which may extend beneath footways
- near public or multi-occupied buildings/premises where cellars, basements, personnel or service corridors/tunnels protrude from the building line, for example hospitals; schools; office blocks; cinemas; theatres; shopping malls/buildings; high rise flats; MOD establishments, etc.
- within the boundary of airports and docks
- within areas of environmentally sensitive sites, rivers, watercourses, listed buildings, archaeological sites or protected trees, plants and animals without authorisation from the enforcing agency
- contaminated sites where PE pipe material may degrade once laid
- landfill sites
- known areas of underground mines, voids, cavities, natural caverns which are close to the surface.

7.3.2 **Operational Activities**

7.3.2.1 *Communication*

7.3.2.1.1 Where more than one team leader is on-site their line management should designate one team leader to have effective control of the site. HDD operations shall not be undertaken unless this representative is in attendance at all times.

Where changes to site personnel occur, a documented handover process shall be undertaken to ensure that new personnel understand all the requirements prescribed in the Safety plan.

7.3.2.1.2 The Competent Person shall be in attendance for the duration of the boring, reaming and pull-back operations. For the safe operation of the HDD activity they shall ensure that an appropriate communication system between the drill rig operator and drill head tracker is used.

Note: This could be via hand signals, two-way radios or some other appropriate method.

Where telecommunications methods are employed, a secondary manual method should be prepared and briefed ready for use should the need arise.

7.3.2.1.3 The route of the drilling shall be monitored continuously while the HDD operation is in progress, to ensure any breakout of drilling fluid is identified as early as possible. This monitoring should be along a corridor at least 50 m either side of the line of the drill path. Monitoring shall continue until the product pipe has been pulled into its final position.

In the event of a breakout of drilling fluid or if drilling fluid does not re-circulate back to the machine, the operation shall be stopped and the emergency plan implemented. The measures outlined in clause 5.2.9.2 should be applied in the event of drilling fluid being released. Other environmental incidents should be controlled through existing procedures.

7.3.2.1.4 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.3.2.1.5 A "Permit to Drill" (see Appendix 7) shall be authorised prior to every drilling operation or significant deviation from the proposed drill path profile, to ensure all the inherent risks identified are controlled. The Permit to Drill should form part of the company's permitry system, for example Safe Control of Operations and issued in line with these control systems and procedures.

The drill rig operator, the competent person and the nominated responsible person who has been authorised to sign such permitry shall all sign the "Permit to Drill". The permit shall be authorised, communicated and issued on site. The permit shall confirm that all hazards have been identified and appropriate control measures put in place to minimise the risk of injury or damage.

Note: A specimen "Permit to Drill" is shown in Appendix 7. Guidance on completion of the permit is given within the same appendix. A copy of the permit will need to be given to all three signatories.

7.3.2.1.6 The person tracking the drill head shall be able to isolate the drilling rig either through remote operation or via signals/communication to the drill rig operator.

7.3.2.2 *Site preparation*

7.3.2.2.1 Tunnels, cellars, foundations, retaining piles, etc., can all be present in the substructure of footways or roads. Detailed checks shall be undertaken to identify the potential presence of these features. Where it is suspected that such features could potentially be affected by HDD operations, detailed information shall be sought from their owners and requests made on the specific protection measures they require.

7.3.2.2.2 Ground conditions can affect the steerability of the drill head. Where known ground conditions will adversely affect the steering of the drilling head, minimum safe working distances to other plant should be increased. Advice from the drilling company should be sought if necessary.

7.3.2.2.3 Where ground conditions require the use of additives (polymers) with the drilling fluid to support the bore hole, the environmental impact shall be considered. Removal of slurry containing additives must be treated as special waste and disposed of in accordance with environmental legislation.

7.3.2.2.4 The level of detail required in the drill path profile will be dependent upon confirmation of the location of buried services/structures. The development of the drill path profile should take into account the following:

- route selection
- entry/exit locations and potential relief excavations
- ground conditions, (rocky, sandy)
- type of HDD rig and associated equipment
- size of back reamers and number of passes
- project requirements
- pipe material, diameter, bending characteristics, corrosion protection
- pipe handling and storage
- buried services/structures
- environment
- disposal of waste.

Note: The above list represents a guide and other site-specific issues will need to be addressed.

7.3.2.2.5 The minimum depth shall ensure that heaving or humping of the surface does not occur.

The maximum depth of lay for steel and PE pipe is:

- electric resistance welded (ERW) steel pipe - 4.3 m
- PE pipe (SDR11 and 17, up to 500 mm diameter) - 6.0 m

Where depths in excess of these are proposed, an assessment shall be undertaken to determine acceptability.

If the depth or other significant factors, for example proximity to buried structures, create undue hazards, an alternative lay method shall be considered.

Note: This could mean choosing an alternative route or laying via open cut at a shallower depth than recommended at the discretion of the Responsible Engineer or their nominated representative with additional protection measures put in place over the gas main or service, for example concrete rafts, concrete tiles, heavy duty marker tape, etc.

7.3.2.2.6 The drill path profile shall be incorporated into the Safety Plan for the project, together with associated method statement for the work activity.

7.3.2.2.7 Following the review and confirmation of all handover documents, a site survey shall be undertaken to establish that the proposed lay method of HDD is appropriate for the site conditions. This initially involves a site-specific risk assessment conducted by a competent person to verify the use of such equipment. The effectiveness of any pre-site survey information should determine the course of action taken by operational personnel in the validation process to follow, as some documentation will have been developed via a desktop exercise and others via an actual site survey.

7.3.2.2.8 Visual verification of above ground conditions relating to the topology of the site, traffic management, accuracy of structural aspects adjacent to the proposed route shall be identified and authenticated. Where sites encompass special engineering difficulties, (See Sub-Section 4.4.5), then on-site discussions with owners/operators should be carried out. Where applicable an area that is relatively clean, flat and free of debris shall be available to lay out the pipe string of the full length of the proposed bore where appropriate.

7.3.2.2.9 All underground services and structures along the entire length of the proposed drill path shall be physically located and identified (See clause 7.2).

7.3.2.2.10 Operational personnel shall have copies of the project proposal documentation (See clause 7.1.3). Using cable and pipe location equipment, visual indicators, the position of underground services and structures shall be marked on the surface between the launch and receive pits, to enable easy identification as work progresses.

Note: Ground probing radar used in conjunction with other approved location devices and a plan provided can assist in the verification of underground services.

7.3.2.2.10 All lateral crossings shall be exposed around their full circumference with an additional 250 mm clearance below. The width of this excavation shall be the greater of either 3 times the diameter of largest reamer or 500 mm either side of the largest reamer. These clearances shall be measured from the drill path centre, the exception being where multiple domestic services cross the drill path profile, (for example water, gas, electric services), by virtue of the route from the distribution main/cable to the termination point of the service that no interference damage will occur.

Note: Existing plant and structures is a key issue to consider before using HDD as an installation technique.

7.3.2.2.10 Unless otherwise advised by owners of underground services and structures, the minimum product pipe clearance between adjacent underground services and structures shall be:

- 1 m when the line of drill is running parallel to underground services and structures
- 0.5 m when crossing over or under services and structures unless a site specific risk assessment can justify any variance and has been agreed with the service/structure operator/owner
- 3 m when the line of the drill is running parallel to gas pipelines with a Maximum Operating Pressure (MOP) greater than 75 mbar, high voltage (33 kV) electric cables, pumping sewers.

Note: Clearances may need to be increased due to the following factors:

- *ground conditions*
- *largest reamer diameter*
- *type of reamer used, for example hollow, finned, etc.*
- *accuracy and reliability of the equipment being used*
- *construction of adjacent services and structures*
- *configuration of underground services crossing or running parallel to the drill path*
- *consequences of damage.*

7.3.2.2.11 During excavation works, ground conditions shall be verified as suitable. Adjacent watercourses shall be identified to enable potential visual verification of environmental spillage during the drilling process. The drill rig operators may require a suitable water supply to be available, so this shall be verified.

Note 1: Water Authorities require licenses for using standpipes greater than 50 mm diameter.

Note 2: Contact with the proposed HDD company can be sought if additional guidance is required.

7.3.2.2.12 Based on the research conducted and findings of the on-site survey, a decision to proceed shall be made by the responsible person. Technical support from the drill rig operatives/company can be sought at this stage if desired.

7.3.2.2.13 The following conditions shall be met if the HDD operation is to proceed:

- all underground services and structures shall have been located, exposed or marked
- an environmental impact assessment shall be undertaken when the HDD operation is within areas of environmentally sensitive sites, rivers, watercourses, listed buildings, archaeological sites or protected trees, plants and animals.

  Note: In addition to the normal operational environmental issues applied to all pipelaying projects, the use of drilling fluids used during the HDD operation require specific attention with regards to containment, handling and disposal.

- the HDD Contractor shall contain, handle, and dispose of drilling fluids in accordance with the following requirements:
  - excess drilling fluid shall be confined in a containment pit/vessel at the entry and exit locations until recycled or removed from the site
  - precautions shall be taken to ensure that drilling fluid does not enter roadways, streams, storm or sewer pipes, and/or any other drainage system or body of water
  - unintended surfacing of drilling fluid shall be contained at the point of discharge and recycled or removed from the site
  - drilling fluids that are not recycled and reused shall be removed from the site and disposed at an approved disposal site
  - drilling fluids shall be completely removed from the construction site prior to back filling or restoring the site

- collection, transportation, and disposal of drilling fluids shall be environmentally safe and comply with local and government regulations. Drilling fluids containing additives shall be treated as "special waste"
- drill rig operators shall be aware of loss of fluid and inform the Competent Person to investigate
- any loss of drilling fluid into the ground, surface or a watercourse shall be reported immediately as an environmental incident and the operation stopped.

- a risk assessment regarding the use of hazardous substances such as the drilling fluid, Bentonite and hydraulic oils used in HDD operations, must be undertaken in accordance with COSHH. The findings of the assessment, controls required and any residual risk must be communicated to people who use the chemicals.

If the decision is taken to proceed, then development of the Safety Plan can continue, procurement of the HDD team can start (if not already undertaken) and site preparations can start. The competency of drilling service providers shall be established prior to their attendance on site.

If the decision is taken not to proceed, an alternative route or lay method should be adopted.

7.3.2.3 *Pilot bore*

7.3.2.3.1 If there is an intervening time period between the initial site survey and the commencement of the job, work conducted in the site survey shall be verified to ensure no changes have taken place.

Note: This includes checking all underground services and structures are located, exposed or marked as stated in Sub-Section 7.2.

7.3.2.3.2 The competent person shall liaise with the drill rig team is ensure that their safety, the safety of the engineering team, staff and members of the public are maintained at all times during the HDD operation. The competency of the drill rig operator, should be verified (See clause 7.3.1.1).

7.3.2.3.3 The drill rig operator will have identified the boundary required for the HDD equipment and ancillary vehicles including site access and egress routes as applicable. The competent person shall ensure that the site complies to approved standards.

Note: This includes signing, lighting and guarding, traffic management, safe working practices, site-specific instructions provided from the Safety plan and job instructions from site set-up to closure.

An exclusion zone shall be set up around the drill rig using appropriate fencing and barriers, providing a minimum of 1 m between the two to initially prevent unauthorized access to the drilling rig, (including operational personnel not involved in the process of drilling). Fencing should be provided with splash screens to contain any fluids within the work area during the launch and receive phases. The product pipe string area shall also be protected.

Where anchorage of the drilling rig is required the Competent Person shall confirm that no damage will occur by using the anchoring system employed.

7.3.2.3.4 Additional support vehicles are used during the drilling operation present their own unique hazards and any site risk assessment shall include information relating to these. Such hazards will include but are not limited by:

- loading and off-loading of the drill rig to/from its transporter

- positioning of such vehicles and any interconnections with the site operations, for example hoses
- where a tanker is used for the drilling fluids all hoses shall be checked prior to use
- the surface loading of such vehicles when not located on a carriageway.

7.3.2.3.5 Before operating any equipment, a review of emergency procedures shall be carried out and checked to ensure that all safety precautions have been taken**.** A test check must be made to establish that communication with the emergency services and emergency call centres for the various utilities, oil pipelines operators, etc. can be made prior to starting drilling operations. Such testing will need to be made several times during projects involving significant lengths of main or in known areas of poor reception.

7.3.2.3.6 Any pneumatic and hydraulic systems shall be checked to ensure they are fully discharged before disconnecting or connecting hoses or equipment.

7.3.2.3.7 A strike alarm should be fitted and checks should be undertaken by the operator to ensure the cable strike alarm and emergency stop mechanisms work properly.

Note: Alternatively, the indication could be via a blast from the bore-hole being drilled.

7.3.2.3.8 All personnel shall wear the required PPE, including as appropriate

- dust masks and goggles (required when mixing the drilling fluid)
- earthing mats (dependent upon the type of drilling rig employed).

In the event of a cable strike, the drill rig operator shall turn off the ignition switch or push remote machine stop button as the drill rig may have become "electrically live". The operator and any other person standing on grid mats shall remain where they are and must not leave the rig until the source of the strike alarm/blast has been established and made safe. No attempt must be made to disengage the boring tool or the back reamer device from the suspected damaged cable.

The competent person shall inform the local electricity company and ensure that no-one approaches the drill rig until resolution of the fault has been finalised.

7.3.2.3.9 Fire extinguishers shall be provided by the drilling rig operator and mounted near the power unit but away from possible points of ignition. These fire extinguishers shall always be classified for both oil and electric fires.

7.3.2.3.10 Prior to commencing the preparation of drilling fluids on sites, it shall be ensured that prevention measures are applied to prevent water pollution damage. These consist of the following:

- ensure that sediment controls are in place prior to disturbance
- maintain sediment controls throughout the construction and reinstatement processes
- minimize the overall disturbance whenever possible
- protect disturbed areas throughout the construction process
- prevent storm water runoff from entering disturbed areas
- never intentionally discharge construction contaminants directly into rivers, ditches, water courses or storm systems.

7.3.2.3.11 The contractor should, at a minimum, implement the following specific best management practices:

- provide temporary erosion protection whenever possible:

- mulch, seed, or gravel may be applied, even if a disturbed area may be disturbed again or other permanent measures of stabilisation are to follow
- cover spoil with a tarpaulin or contain with a sediment barrier.

- contain disturbed sediment on site:
  - use sediment barriers such as silt fence, sand bags, straw bales, rock checks and/or sediment traps to contain sediment on the construction site
  - existing vegetation may be used as a sediment filter where minimal grades and sheet flow runoff will occur
  - ensure that all sediment barriers are installed and functioning properly.
- avoid causing flooding in roadways and adjacent footways:
  - do not cover existing culverts and storm inlets as far as reasonably practicable
  - ensure that sediment is removed from sediment traps and filters after all storm events.

7.3.2.3.12 The final route of the drill path profile shall be determined.

7.3.2.3.13 Prior to drilling, where applicable, the drilling fluids should be mixed in sufficient quantities to complete the pilot bore, pre-reaming and reaming passes.

Note: When the drill rig is properly set up and anchored with the drilling fluids mixed/available and the tracking unit calibrated, the pilot bore can be initiated. The pilot bore is drilled along the planned drill path profile from entry to exit.

The drill head shall be tracked and the position marked at a minimum of every 3 m to ensure the designed path is being followed. The drilling team shall track the position of drill head and they shall mark the position and depth as the bore progresses. The responsible person or competent person should either monitor the actual route or be advised of any deviation (defined as leading to a breach of the minimum clearances stated in clause 7.3.2.2.10) from the proposed drill path profile.

7.3.2.3.14 Where lateral crossing of underground services and structures which have been exposed are no longer on the line of the pilot bore due to deviation as the bore is made, these excavations shall be extended to ensure that no damage occurs as the pilot and subsequent reaming bores takes place.

7.3.2.3.15 Once the pilot bore has been completed, a review of its path shall be taken to ensure that the subsequent reaming process will not affect adjacent underground services/structures or create road heaving or humping of the surface.

7.3.2.3.16 The drilling unit shall not be operated where leakage of flammable gas is detected.

7.3.2.3.17 The drilling rig shall be turned off during changing of the drill head to the back reamers and subsequent changes of back-reamers.

Changing the drill head to a back-reamer and subsequent increases in the size of back reamers will involve a lifting operation that shall be carried out by a competent person, properly planned, controlled and executed. The drilling rig shall be turned off during these operations and also when preparing to attach the product pipe.

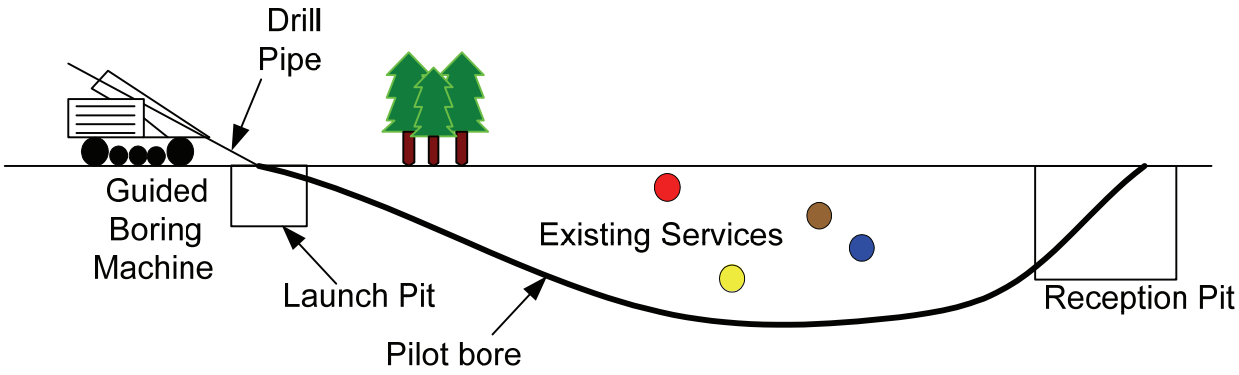

FIGURE 1 - ILLUSTRATION OF PILOT BORE

7.3.2.4 *Reaming*

7.3.2.4.1 Following a successful pilot bore, the reaming process may begin.

Note: The number of reaming passes depends on the diameter of the product pipe compared to the diameter of the pilot bore, ground conditions and driller's specifications. In loose or soft soils, the number of required reaming passes will typically be less than if hard soils or rock are encountered. This is primarily due to the torque limitations, cleaning plant capacity and pump capacity.

The final bore diameter shall be larger than the product pipe diameter to reduce frictional pullback loads and to facilitate flow of the drilling fluids around the product pipe. Table 1 provides recommended relationship between the product diameter and reamed diameter.

PRODUCT DIAMETER	FINAL REAMED DIAMETER
Less than 250 mm	Diameter of product + 50%
250 mm to 630 mm	Diameter of product + 30%
Above 630 mm	Diameter of product + 300 mm

Note: Different drill rig operators will have their own specifications based on their experiences under various conditions and rig requirements.

TABLE 1 - RECOMMENDED RELATIONSHIP BETWEEN THE PRODUCT DIAMETER AND REAMED DIAMETER

7.3.2.4.2 The product pipe should be prepared for installation in advance of the reaming process. The specific steps involved will be dependent on the size of the product pipe but shall be prepared in accordance with company engineering procedures.

Where a pipe string has been constructed, this should be risk assessed to determine any precautions that need to be put in place.

7.3.2.4.3 On completion of the final ream, the product pipe should be prepared for pullback. A pulling head is attached to the product pipe, which should incorporate a breakaway swivel between the reamer and the pulling head to prevent rotation of the product pipe.

The product pipe shall be properly positioned and supported to enter the bore and pipe rollers used to prevent scratches/gouges and offer the least friction during pullback.

Breakaway swivels should be used to prevent overstressing of the pipe as it is installed.

Note: These are designed to fail before the pullback loads exceed the safe capacity of the product.

The breakaway swivels shall be designed to limit the maximum allowable "pull-in" force when pulling MDPE pipe.

Where the HDD equipment utilises stress-measuring devices, these shall be monitored throughout the pullback to ensure that the prescribed stress tolerances are not exceeded.

Pullback should be completed without interruption, to reduce the risk of the product pipe becoming lodged in the bore.

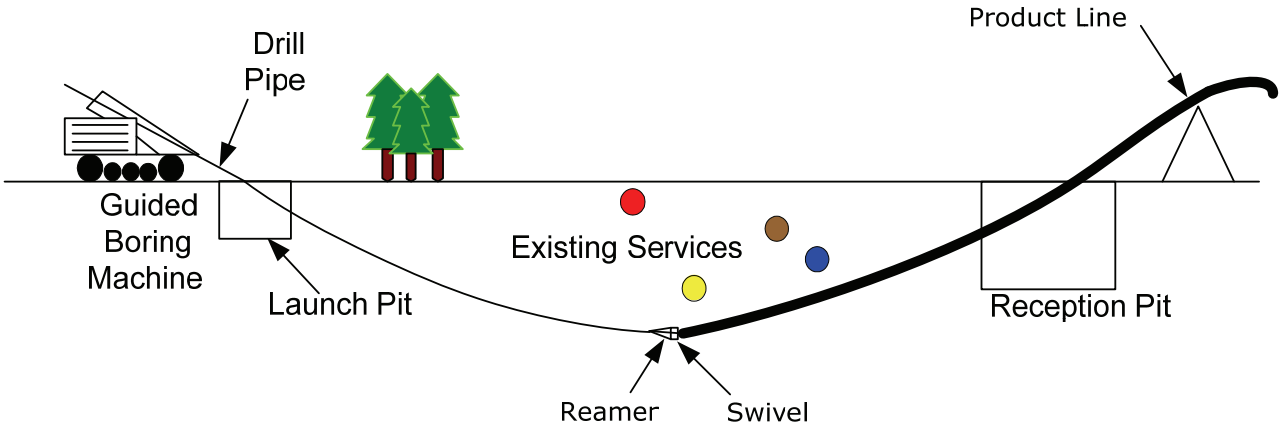

FIGURE 2 - ILLUSTRATION OF PULLBACK

7.3.2.4.4 Due to the tensile stresses imposed during pullback, there is a possibility of the breakdown of components within the attachment mechanism, for example failure of the breakaway swivel, detachment of pulling head, failure of PE joint, etc. Where failures of this nature occur, an excavation should be made as appropriate at the point of failure to identify the potential causes and facilitate repair and reconnection.

The drill rig shall be isolated during such excavation and repair works.

Any tension on the pipe/drill string shall be released prior to excavating.

Release of components may involve operating the drilling rig. If the drill rig is operated to free or retrieve the drill rod string, there shall not be any person within the excavated trench.

7.3.2.4.5 If required, a short section of product pipe can be pulled through the reamed hole to identify if the pipe will be damaged by the pull through process.

On completion of the full pullback process, the surface of the leading pipe shall be examined. Where PE pipe has sustained damage of more than 10% of the pipe wall thickness or steel pipe coating has been damaged, examination of the pipe surface at suitable intermediate excavations shall take place to help pinpoint the source.

Note: It is recommended that the inserted pipe be sectionalised preferably starting in the middle of the bore if suitable.

Where unacceptable damage is not found at the first excavation, a second excavation should be made at a point near the reception pit (6-10 m from pulling head) as the pullback may have dislodged the source following the initial damage. If evidence of continued damage is found, sectionalising should continue to pinpoint the source. Once the source of damage has been identified, an assessment shall be made to determine the methodology for replacement of the damaged section, for example pull out and re-ream, open cut, new bore.

Where damage is present at the first excavation, a decision should be taken to either:

- request Network Analysis support to confirm that a reduced diameter pipe can be inserted within the damaged pipe. Network Analysis will determine if this method provides an interim or permanent solution
- excavate a new launch pit at the point of damage and utilise undamaged pipe in situ
- abort the bore and repeat entire process
- pullout damaged section of pipe (this choice will be time dependant due to the potential for the bore to collapse and for the fluid to solidify), re-ream and pullback new section.

7.3.2.4.6 The drilling team shall be responsible for clearing all drilling fluids away from site.

Where ground conditions required the use of additives with the drilling fluid to support the bore hole, the environmental impact and removal of slurry containing additives shall be treated as special waste and disposed of in accordance with environmental legislation.

7.3.2.4.7 The primary responsibility of the drilling team is to begin and terminate the HDD installations at the locations shown on the "Permit to Drill". After the pipe has been installed, the entry and exit pits shall be cleaned of drilling fluid and cuttings. The engineering team shall be satisfied that the final connections can be satisfactorily made without misalignment to the pipe caused by the entry and exit angles used to insert the pipe.

Note: Where required, a short section may be either re-drilled or open cut to ensure the final connections are acceptable.

7.3.2.4.8 When a main has been pulled in, a relaxation time shall be allowed.

Note: Minimum relaxation times for MDPE are:

- *2 hours for MOP not exceeding 75 mbar*
- *6 hours for MOP exceeding 75 mbar but not exceeding 2 bar*
- *12 hours for MOP exceeding 2 bar but not exceeding 4 bar.*

7.3.2.4.9 Where pipes are connected to an existing metallic system, provision shall be made to protect the existing mains from end loads imposed by the new pipe.

7.3.2.4.10 Pressure testing and commissioning shall be carried out in accordance with IGEM/TD/1, IGE/TD/3 or IGE/TD/4, as appropriate.

7.3.2.4.11 During the drilling operation, the drilling team should mark the position and depth of the drill head on the surface of the ground. This information shall be used to complete the as-laid drawings, being mindful of the variance in depth of the drill head to the crown of the pipe product.

Note: For example, if installing 355 mm diameter pipe, the actual depth of the crown of the pipe will be shallower than the markings shown for the drill head as this will have been taken from the centre of the pilot bore.

7.3.2.4.12 The responsible engineer shall ensure that processes are in place to monitor personnel who authorise "Permits to Drill" to check their performance through both desk top and site inspection. Specific desk top and site inspections shall be undertaken on the basis of the requirements detailed in this section by an appropriate skilled and independent authorising engineer:

- a minimum of one desktop inspection of a completed Permit to Drill per authorising line manager per three months
- a minimum of one site inspection of a drilling operation per authorising line manager per annum.

Results of the inspection shall be issued to the responsible engineer. The responsible engineer shall consider the need for revalidating the authority of the responsible person to discharge their responsibilities and/or to determine the requirements for immediate re-training and/or instigate the need and scope of a mentor.

Those organisations that undertake HDD operations shall provide the responsible engineer with documentary evidence confirming adoption of this monitoring programme.

7.3.2.4.13 Data may be stored and retrieved using a variety of forms such as electronic or paper systems. The responsible engineer should select the most appropriate system.

The responsible engineer shall have available a current record showing the scope of each person's competence. This should indicate:

- the competency level of the individual, for example does, coaches
- evidence of training and qualifications
- knowledge of subject matter
- information on practical experience gained.

Note: For drill rig operators, this may simply be a reference to a certificate(s) of attendance for a particular drilling machine, held on file. Certain restrictions will apply for example, type of drilling rig.

7.3.2.4.14 The responsible engineer shall have available current training and assessment records of responsible persons and competent persons employed that are engaged on HDD activities and have access to the training and assessment records of employees of other contracting companies who may be used.

7.3.2.4.15 The competent person, on behalf of the responsible engineer or their nominated deputy, shall maintain all Permits to Drill in the project file. Associated documents shall also be maintained in the project file, for example drill path profile, hand-over documentation, etc.

7.3.2.4.16 All pipes installed using this technique shall have accurate plans returned showing the exact route of the installed pipe.

7.3.2.4.17 Independent audits shall be undertaken of the management system, in accordance with company audit procedures

Note: One prime purpose of the audit is to review the arrangements for the issue of Permits to Drill, to assess if the system is operating effectively, monitor performance standards and to assist with any ongoing improvements/enhancements.

Responsible engineers should review the findings of any audits carried out on their behalf. Any system enhancements, training requirements or other issues identified should be addressed as soon as practicable.

7.4 IMPACT MOLING

7.4.1 General

Impact Moling is a technique in which a pneumatic piercing tool is used to create a bore hole. The ground is compacted and displaced rather than excavated and removed, to minimise disruption and reinstatement.

7.4.2 Operational activities

7.4.2.1 *Communication*

7.4.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.4.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.4.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.4.2.2 *Site preparation*

Note: A pre-moling checklist is provided in Appendix 5.

7.4.2.2.1 The site survey shall determine the route of the proposed installation and excavate as many trial holes as required to determine the depth and route of all underground apparatus using plans; locating equipment; on-site indicators (boxes, reinstatement patches) and safe digging techniques.

7.4.2.2.2 All plant shall be located, marked and labelled with type (see clause 7.2.2), depth and ratings on the ground surface.

7.4.2.2.3 A survey shall be carried out of the area into which the mole will be launched and received.

7.4.2.2.4 On completion of the identification of underground plant, a thorough assessment of the suitability of the soil displacement technique should be undertaken by surveying the floor of the launch-pit for underground apparatus. If traces of plant are found, or if the location is too congested for the use of the launch cradle, a further risk assessment should be undertaken to either:

- relocate the launch cradle or
- launch from a different location
- launch by hand, which shall be supported by a risk assessment
- adopt a different laying technique.

7.4.2.2.5 Site preparation is essential to the success of the soil displacement hammer (SDH), and the following shall be taken into account:

- extreme care has to be taken to avoid damage to the environment, other utility plant and injury to operatives by striking underground cables
- excavation of the launch and retrieval pits to a suitable depth

  Note: The recommended minimum depth is 10 times the diameter of the SDH to reduce the potential ground heave along its bore path.
- where possible there should be a clear line of sight.

7.4.2.2.6 The reception pit should be excavated so that the SDH can be:

- retrieved and
- reversed, pulling polyethylene (PE) pipe behind it.

7.4.2.2.7 The air hose shall be marked prior to launch, to indicate the expected distance of travel of the SDH.

7.4.2.2.8 In general on site, the following apply:

- during the launch operations, the excavation should be kept clear
- insulating boots and gloves shall be worn when operatives are actually in contact with the impact moling equipment while it is in use.

7.4.2.2.9 When assembling equipment, the following checks shall be carried out to ensure that:

- the airline is attached to a suitable compressor ensuring a hose restraint is in place. Potential air delivery pressure should be a maximum of 6-7 bar
- the air line is not blocked or kinked
- the air supply has a water separator. All hose connections should be supported with whip checks.
- there is lubricant in the reservoir
- the air hose is attached to the lubricator, noting the direction of operation
- the thrust-boring airline is attached to the lubricator and SDH, respectively
- a mark indicates the expected length of travel on the hose
- visual inspection should include hoses and airlines for damage, connectors work correctly, the impact hammer is not damaged and the piston moves freely and the hose connection to the machine body is not damaged
- the piston is at the rear of the machine
- hoses will not create a tripping hazard
- the SDH is in the forward operating position.

7.4.2.2.10 Equipment shall be isolated from energy sources by, for example:

- pneumatic - ensuring all pneumatic systems are fully discharged before disconnecting or connecting airlines, hoses or equipment
- electrical - when touching a mole that is being launched or received always checking for stray voltage using a suitable testing device and wearing the appropriate PPE. The mole shall not be touched if it is believed it may have come into contact with a cable.

7.4.2.3 *Moling*

7.4.2.3.1 When launching the SDH consideration shall be given to:

- where practicable using a launching cradle
- sighting the SDH using a sighting rod and marker stick
- launching the SDH in a controlled manner
- increasing the air feed (to a maximum of 0.5 m^{-1} min)
- monitoring the progress of the SDH
- whenever possible, launching from the most congested side of the road. Impact moling towards cables should be avoided
- when working on an incline, moling up hill
- avoiding contact with any plant when the mole is launched
- avoiding direct contact with the air hose/SDH by the operator during operations
- aligning the SDH to give the maximum clearance from other underground plant, but not less than 250 mm clearance for bore lengths up to 8 m.

7.4.2.3.2 During operation, consideration shall be given to:

- ensuring that, immediately after launching, the operative steps out of the excavation. The launch cradle should not be removed until the operation is complete and it is safe to re-enter the excavation. Continual observation of the progress of the SDH and flight of the bore should take place from outside of the excavation
- when nearing its destination indicated by the mark on the hose, carefully controlling the travel speed
- ensuring operatives do not stand in the reception pit when the SDH is entering the reception pit
- ensuring there are two operatives on site throughout the impact moling operation
- constantly monitoring the progress and position of the SDH. If it is suspected that the SDH is deviating from the line or has met an obstruction, the machine shall be stopped and the cause investigated.

7.4.2.3.3 On completion of the impact moling operation:

- a visual check of the borehole shall be undertaken to establish if there is any evidence of damage to other plant, for example, water seepage from storm or waste water pipes
- an approved gas volume detection instrument should be used to check the annulus of the mole bore for gas readings (lower flammability limit (LFL)).

7.4.2.3.4 When inserting PE pipe, the following shall be carried out:

- ensure that the pipe is inserted or towed in accordance with the manufacturer's instructions
- attach an approved towing head or nose cone to the front of the PE pipe
- visually check the inserted pipe for evidence of damage. Any pipe showing damage greater than 10% of the wall thickness shall be removed
- ensure that sufficient pipe is extended out of the borehole to make the connection.

7.5 AUGER BORING AND ROTARY DRILLING

7.5.1 General

These techniques use an array of cutting, lubricating and monitoring equipment. The risks when carrying out a site survey and installing equipment are the same for both auger boring and rotary drilling.

The site survey shall be carried out to determine the location of any other services.

Note: The site survey is the same as for any other trenchless technique.

7.5.2 Operational Activities

7.5.2.1 *Communication*

7.5.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.5.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.5.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.5.2.2 *Site preparation*

7.5.2.2.1 Care shall be taken to ensure that the wall of the working pit, which will contain the thrust force of the auger or drilling operation, is strengthened accordingly and will not collapse under the working load.

7.5.2.2.2 Removal of spoil shall also form part of a separate risk assessment considering depth of installation and amount of spoil being produced.

If, when rock drilling, drilling fluid is used as a lubrication/cutting removal agent, measures should be taken to remove the returned slurry from the working pit in a controlled manner subject to environment codes of practice. Health issues should also be addressed (see Section 5).

7.5.2.3 *Boring and drilling*

7.5.2.3.1 Personnel working in excavated areas as a working pit, shall adhere to the codes of practice regulating the excavation.

Note: In most instances, both the entry (working) and exit (receiver) pits will be supported by either a timber or prefabricated frame.

7.5.2.3.2 Lifting and manhandling of drilling rod, steel casings and clamps, pilot rods, cutting heads and reamers, auger flights and product pipe in and out of the excavated exit and entry pits shall be assessed as an independent operation considering the type and size etc. of the operation.

7.5.2.3.3 Care shall be taken in the positioning of the hydraulic power pack adjacent to the working pit and the distribution of the feeder hoses from the power pack to the auger machine.

7.5.2.3.4 Adequate methods of machine shut down shall be in place during auger/pilot rod rotation in case of any contact by personnel. No uncontrolled movement of the auger or drilling machine should be allowed during section changes.

7.6 MICROTUNNELLING

7.6.1 General

7.6.1.1 Microtunnelling operations invariably involve working within the confines of an access and reception shaft. These shafts will, generally, contain powerful hydraulic rams, heavy overhead loads and fluids under high pressure. The potential for the accidental release of any of these items is great and the consequences from such releases shall not be underestimated in terms of operative safety.

7.6.1.2 Only qualified fitters and electricians experienced in microtunnelling plant should be permitted to install and test the equipment to be used.

7.6.1.3 All operators, drivers, plant operators and labourers should be fully experienced in this type of work (see Section 9).

7.6.2 **Operational Activities**

7.6.2.1 *Communication*

7.6.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.6.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.6.2.1.3 There shall be clear communication between the machine operator and the pit bottom operations.

7.6.2.1.4 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.6.2.2 *Site preparation*

7.6.2.2.1 The jacking frames and rams should be at right angles to the thrust wall. The thrust wall should be designed to provide sufficient reaction against the shaft or pit wall for all the jacking forces needed for the total drive plus an adequate factor of safety against failure.

7.6.2.2.2 All plant and equipment shall be set up such that the crane operator/microtunneller driver has a clear view of all operations taking place at the surface and in the shaft or pit bottom.

7.6.2.2.3 Wherever possible, a listening device should be installed in the head of the microtunnelling machine to warn the operator of changes in ground conditions or obstructions. This is particularly important where unexploded ordnance may be known to be present in the area.

7.6.2.2.4 All interlocks and safeguards shall be fully operational such that the slurry circulation pipes cannot be opened under pressure, pumps cannot be started with pipes open and jacking rams cannot be operated without the operation of a "Deadman" release button.

7.6.2.2.5 All pipes, valves and emergency cut-off systems shall be marked/labelled adequately and displayed. These labels and markings shall be inspected, cleaned and maintained regularly.

7.6.2.2.6 All rotating shafts and equipment shall be fully guarded at all times.

7.6.2.2.7 Overhead cables should be signed and guarded.

7.6.2.2.8 All advancing and retracting rams shall be fitted with an audible warning system.

7.6.2.3 *Drilling*

7.6.2.3.1 Slurry spillages should be cleaned up immediately to prevent slippery surfaces.

7.6.2.3.2 Access ladders shall not be used during lifting or lowering of loads.

7.6.2.3.3 Clear, unobstructed, views of the working areas shall be available to the crane or hoist operative at all times. High intensity lighting should be in place to light all working areas without shadows.

7.6.2.3.4 Entry into the micro-tunnel bore shall not be permitted except for emergency repairs. Full confined space entry precautions are required for this situation and shall be in place before entry is effected.

7.6.2.3.5 All equipment and plant shall be dismantled and removed from the jacking area by qualified personnel.

7.6.2.3.6 All final grouting operations shall be undertaken by experienced and qualified personnel equipped with suitably approved PPE.

7.6.2.3.7 All equipment shall be stored in an approved manner while awaiting dispatch from site.

7.6.2.3.8 All electrical feeds, sewer connections and waste water outlets shall be sealed off and made safe.

7.6.2.3.9 All access points and shafts shall be left secured and tamper-proofed. All site hoarding shall be removed and existing fences returned and repaired to an approved standard.

7.7 PIPE RAMMING AND PIPE JACKING

7.7.1 General

7.7.1.1 Pipe ramming and pipe jacking techniques can be used in most soil conditions. These techniques are, generally, not used where rock conditions prevail. Reference shall be made to the manufacturer's instructions to assess the suitability of the ground, against the capability of the equipment.

7.7.1.2 Pipe ramming and pipe jacking systems perform differently depending on ground conditions and changes in strata, both natural and artificial. Reference should be given to this when introducing safe working distance from underground equipment. Utility Companies recommended safe working distances from their buried plant should be maintained.

7.7.1.3 Consideration shall be given to the depth of installation to avoid potential damage at the surface.

7.7.2 Operational activities

7.7.2.1 *Communication*

7.7.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.7.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.7.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.7.2.2 *Site preparation*

7.7.2.2.1 Pipe ramming is a noisy operation and the requirements of clause 5.2.13 must be implemented. Ear protection should be available and used at all times.

7.7.2.2.2 Dust producing materials should be stored correctly on site and disposed of to a licensed site.

7.7.2.2.3 Anti-flash protection screen should be used to protect any persons in close proximity to welding operations.

Appropriate PPE shall be worn for welding/cutting operations, for example welder's/dust mask, gloves, etc.

7.7.2.2.4 Special consideration should be given to underground structures. Detailed plans and recommendations should be obtained from the owner.

The position of any known physical or artificial obstructions should be determined using existing records.

7.7.2.2.5 A bore route plan should be confirmed on the site before commencement of the installation works (See Sub-Section 4.4.6).

7.7.2.2.6 A risk assessment shall be carried out prior to any welding operation to determine any hazards in the vicinity, which may include flammable gases.

7.7.2.2.7 Welding equipment shall be maintained in accordance with manufacturer's instructions.

7.7.2.3 *Ramming and jacking*

7.7.2.3.1 All electric plant associated with welding operations should be 110 volt 3 phase 50 Hz.

7.7.2.3.2 For cutting operations damped equipment should be used.

Note: The use of damped cutting equipment will help to prevent a dusty atmosphere being created.

7.7.2.3.3 A rigid launching cradle should be used to ensure the pipe is installed safely and accurately.

7.7.2.3.4 Pipe jacking rams shall be installed correctly and provide an evenly distributed force to the surface of the pipe.

7.7.2.3.5 Compressed air equipment, such as the ramming hammer and compressor, shall be in a good state of repair.

7.7.2.3.6 During the pipe installation works, the line and level of the pipe shall be monitored at regular intervals to ensure the proposed bore path is maintained.

7.7.2.3.7 When the removal of the spoil from the inside of the newly installed pipe is to be undertaken using the compressed air evacuation method, all personnel shall have evacuated the excavations prior to this operation commencing.

7.8 PIPE SPLITTING AND PIPEBURSTING

7.8.1 General

7.8.1.1 A pipeline with inadequate capacity, or whose structural condition is too poor for rehabilitation can often be replaced with minimum excavation by using an in-line pipe replacement technique.

The most commonly used technique is pipebursting which uses an axial jacking or pulling force, acting on a tapered bursting head to fracture the existing brittle pipe material through which it passes, drawing in behind it the new pipe string, consisting usually of polyethylene material.

Pipebursting uses a powerful hydraulic pushing and pulling machine, acting on high tensile steel rods which draw the bursting head through the main. The new pipeline is drawn in behind the head. Typical pulling forces in the range of 20 to 230 tonnes are common, depending on pipe diameter and material.

Where ductile materials, or brittle materials containing a series of steel repair collars are found, the bursting head should be modified to provide a cutting action to split the material and open it up sufficiently to provide the required clearance for the new pipe string to be drawn into place. This process is pipe splitting and is applied to materials such as steel, ductile iron and polyethylene.

Note: In addition to gas and water main replacement, pipebursting is commonly used for the replacement of failing and undersized sewers, where significant increases in size have been achieved. Increases in size from 375 mm to 600 mm are not uncommon. Sewer bursting operations are typically in the diameter range 150 mm to 375 mm, but sizes up to 1200 mm have been achieved.

7.8.1.2 Designers and managers shall be trained on the suitability of bursting as a replacement technique and understand its limitations.

7.8.1.3 Supervisors shall be trained on the application of the bursting technique in an operational environment. Additionally they require training on the inspection and maintenance requirements of the equipment.

7.8.1.4 Operators shall be trained in the use of the equipment and the application of bursting activities in an operational environment, with particular emphasis on understanding the hydraulic forces that will be imposed on the walls of the reception pit by the action of the bursting machine.

7.8.2 Operational activities

7.8.2.1 *Communication*

7.8.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.8.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.8.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.8.2.2 *Site preparation*

Note: A pre-bursting checklist is provided in Appendix 6.

7.8.2.2.1 Underground obstructions shall be identified (See Sub-Section 7.2).

7.8.2.2.2 The site survey should pay special attention to the proposed location of launch and reception pits as they may require significant excavation, dependant on size of equipment planned for use. If the survey reveals buried plant in these locations then a further risk assessment should be undertaken to decide if the location should be removed.

7.8.2.2.2 On completion of the survey a further assessment of the suitability of the technique should be made.

Issues which shall be addressed in determining the suitability of the technique for the specific project are:

- depth of cover of mains
- existing pipe material
- presence on main of repair collars from known areas of repair or replacement
- areas of rock through which main may have been laid
- location of and proximity to other plant and structures
- can replacement welded pipe string be located safely without causing access or traffic hazards
- public safety.

7.8.2.2.3 The following shall be taken into account:

- extreme care shall be taken to avoid damage to the environment, other buried plant and injury to operatives from damage that may be caused to any buried object
- excavate the launch and reception pits to the required depth, ensuring that the trench walls, particularly forward and back are of sufficient strength to resist the thrust of the hydraulic machine, particularly at the reception point. Guidance from the machine manufacturer may be needed here
- the existing main or sewer should be carefully cut at the entry to the reception pit so as to present a thrust face to the machine to reinforce the stability of the operation
- preparations must be made to secure the new welded PE pipe string above ground, and protect it from damage from passing vehicles or avoidance of risk to the general public who may encounter the site. Where the site size is limited, or pipe diameter does not allow the use of coiled pipe it may be necessary to restrict the length of the pipestring and add further lengths as the operation proceeds. PE pipe in coils up to 180 mm in diameter are available for use.

7.8.2.2.4 Due to the outward expansion of the surrounding ground, as the tool passes through the existing main, consideration shall be made for potential damage to any adjacent services and the potential for heave of the surface levels.

Any service connections or sewer laterals shall be disconnected by carrying out small excavations at each point of connection.

Note: The frequency of these connections will be considered in determining the economics of trenchless replacement as against conventional open-cut methods.

7.8.2.2.5 The use of continuous, welded PE pipe is common throughout this process. However, for sewer replacement, often requiring manhole access, short, mechanically-jointed pipes should be used.

Note: These may be of PE, clayware or concrete construction.

7.8.2.2.6 The correct size and type of equipment should be selected to suit the main being replaced and the pipe planned to be inserted by taking into account the depth of cover of the main. Pipe bursting carried out on shallow mains or using oversized expanders to increase carrying capacity may cause significant upward ground movement, with resultant surface damage.

7.8.2.2.7 Difficult access in congested urban areas may restrict the choice of equipment available for a specific project. Manufacturers shall be consulted, if in doubt as to the suitability of plant.

7.8.2.2.8 If any doubt exists as to the condition of a chosen main, with regard to the presence of steel or ductile iron repair collars, a pipe splitting head should be chosen for use.

Note: If a pipebursting head encounters a steel fitting that it cannot break, it may push the fitting along the main, ahead of the burster, resulting in considerable ground disturbance and possible damage to adjacent services.

7.8.2.2.9 Pipebursting equipment shall be inspected and deemed satisfactory before use. This should include:

- a visual inspection of all flexible hoses and connectors
- checking the pulling rods for damage

  Note: Damage may show as cracking, bending or damage to the coupling threads.
- ensuring the machine is free to travel across its full range of operation, both forwards and back.

7.8.2.2.10 Where specific hazards are identified in the operational risk assessment, a safe system of work will be required. This shall consist of a risk assessment, a method of work that minimises the risks and adequately controlled which will require the use of a permitry system.

Note: Certain operations identified in the risk assessment, safe method of work or the site specific risk assessment may identify the need for all or part of the operation to be controlled by a permit to work system. For example work near a pipeline or deep excavation.

7.8.2.3 *Splitting and bursting*

7.8.2.3.1 Noise levels may be high and appropriate ear protection should be provided and worn.

7.8.2.3.2 Dust masks shall be worn to protect against inhaling dust from inside old mains.

7.8.2.3.3 When lifting the hydraulic burster and rod system into the excavation the requirements given in Sub Section 5.5 shall be adhered to.

7.8.2.3.4 Where there are deep launch and reception pits access should be by entry/exit systems.

7.8.2.3.5 Contact with hydraulically-powered jaws and moving pull-rods should be avoided.

7.8.2.3.6 Insulating boots and gloves shall be worn during the launch and receive operations when operatives are actually in contact with the bursting machine and rod system.

7.8.2.3.7 Progress of pipebursting shall be carefully controlled where it crosses over or under other buried services as damage may occur from movement of broken pipe fragments.

7.8.2.3.8 Attention shall be paid to the depth of the main or sewer to be replaced as a shallow depth will indicate the likely damage to surfaces from ground heave, should the technique proceed as planned.

Note: As a general guide, any mains above 150 mm in diameter or laid at a depth less than 750 mm will require a special risk assessment of damage that may be caused.

7.8.2.3.9 Care shall be taken when handling power operated machines which offer a significant chance of injury to the operator if not handled correctly.

Note: The machine may carry warning signs to protect the operator and indicate possible dangers from:

- *crushing by moving parts. Crushing can occur in the following operations, lowering burster into excavation, moving burster in excavation, when installing/removing the hydraulic rods* or *when securing the burster against thrust blocks at ends of excavation*
- *injury from moving components*
- *lateral movement of the rod system and the return thrust of the machine in pull-back mode.*

7.8.2.3.10 Safety controls shall be identified and used at all times. These may include:

- emergency stop switch
- electricity alert, if a current-carrying cable is struck during the operation, making the machine live
- earthing rod, cable or mat
- machine covers to shield operator, where possible from moving parts

7.8.2.3.11 Operatives on pipe bursting sites shall be aware of the dangers of tripping from:

- hydraulic hoses
- electric cables
- falling over extended pipe string
- tools left around the work site.

Danger exists due to the presence of pressurized hydraulic oil:

- switch off the hydraulic power unit before making any attempt to work on the hydraulic system.

7.8.2.3.12 During the operation, operatives shall not reach into the machine and shall stand clear of the machine.

Note: Danger of crushing exists at the receive pit, when:

- *the guide rod arrives into the excavation*
- *guiding the bursting head or expander into the host pipe.*

7.8.2.3.13 When the machine is working, the machine operator should be in the launch/receive pit

7.8.2.3.14 Operatives shall be made aware of the mechanical tension or compression which exists in the rod string.

Note: Occasional breakage of rods can occur.

7.8.2.3.15 When bursting the old pipe, the broken pipe pieces are pushed aside into the surrounding soil. If insufficient clearance exists, damage may occur, creating the following hazards which shall be considered:

- fibre optic telephone cables
  If damage has occurred do not look into the glass-fibre cable, which poses a risk of eye injury
- electric cables
  Pose a serious threat of electrocution
- gas pipes pose a threat of explosion
  Do not light fires. Shut down all engines. Do not operate electrical switches or pull out cable plugs. Secure the damaged area to prevent unauthorized access. Contact the supply company
- water pipes
  Close any available valves. Contact the supply company
- sewer pipes
  Do not climb into shafts or enter pipework as a danger of toxic gasses could exist.

7.8.2.3.16 On completion of the bursting operation a visual check for significant damage shall be made of the newly inserted pipe, where it has emerged into the reception pit.

Note: The action of drawing the new main through the debris of the broken pipe may have resulted in a certain amount of superficial scratching of the outer pipe wall.

If scoring deeper than 10% of the pipe wall thickness has occurred ten further checks shall be made to determine the full extent of the damage. Pipe material damaged to this degree should be rejected.

Note: The condition of the barrel of the pipe can be further checked at each open connection hole, where the pipe can be cleaned and prepared for any required service connections, after testing of the completed inserted main.

7.8.2.3.17 Hard surfaces above the inserted main shall be checked for signs of surface heave. Localised repairs should be considered, as appropriate.

Note: In extreme cases cracking may be visible in bound surface layers where a ripple wave has occurred at a particular point as the expanding head of the burster passed the point, causing the point to momentarily rise and then fall back again, resulting in surface cracking.

7.9 REFURBISHMENT OF PIPES USING LINING TECHNIQUES

7.9.1 General

The techniques covered by this section are the insertion of smaller diameter pipes into existing pipes or ducts, deformable structural plastic liners and cured in place liners.

7.9.2 Operational activities

7.9.2.1 *Communication*

7.9.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.9.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.9.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.9.2.2 *Site preparation*

7.9.2.2.1 An examination shall be made of the existing mains structure including utilities along the full route of the insertion. An assessment of the problems posed by bends and other obstructions in the existing pipeline should be made.

7.9.2.2.2 Care shall be taken in identifying any underground structures and where appropriate, detailed plans and recommendations should be obtained from the owner. This is particularly relevant at launch and reception excavations where additional space will be required to permit access for the insertion of the liner and winch wires.

7.9.2.2.3 Changes of direction and depths of the existing main shall be marked on the ground surface. If there is any doubt about direction or depths, trial excavations should be made.

7.9.2.2.4 Examination of the cable should be made prior to the operation and the SWL of the cable should be greater than that of the winch. Towing eyes and nose cones should be stamped with the SWL.

7.9.2.2.5 All rigs, winches, lifting and towing equipment shall be visually inspected for damage and wear prior to use and shall be securely anchored rather than left free standing.

7.9.2.2.6 The route should be assessed for traffic conditions, vehicular access points, bus stops, pedestrian crossings and other significant features which may affect the location of excavations.

7.9.2.2.7 Winch cables for installing cured in place liners should be of types that minimise twisting forces when under tension. Swivels should be incorporated to prevent the liner from twisting.

7.9.2.2.8 All hoses and their couplings shall be free from leaks. Hoses used for steam or hot water shall be protected against accidental contact by operatives or the general public.

7.9.2.2.9 Radio or other approved types of communication shall be maintained at all times between launch, reception and intermediate points as appropriate.

7.9.2.2.10 Pedestrians shall be excluded from the immediate work area when passing lining rigs, winches or exposed cable under tension.

7.9.2.3 *Lining*

7.9.2.3.1 Where straight lengths of PE pipe are to be used in the insertion process, any storage sites adjacent to the work shall be set up to allow assembly of the pipe string without obstruction to the public.

7.9.2.3.2 Where coiled PE pipe is used, the hazards associated with loading the coil drum onto a trailer shall be assessed. Careful removal of restraining bands shall follow manufacturer's recommended procedures in order to reduce the risk from stored energy.

7.9.2.3.3 Where a winch is used, a sufficient period of time shall be allowed, following insertion, to permit the pipe to recover from the tensile forces applied during the pulling-in process.

7.9.2.3.4 For inserted PE pipe that is subject to extremes of temperature, consideration should be given to anchoring the pipe at positions where movement due to expansion and contraction may damage the pipe.

7.9.2.3.5 Excavations which are made at the launch and receive pit, plus any additional excavation that may be necessary along the route of insertion, must be in accordance with relevant legislation and with the engineer's requirements.

7.9.2.3.6 Working practices within launch, intermediate and reception excavations shall follow appropriate risk assessments.

7.9.2.3.7 Only purpose-built winching equipment shall be used for a winching operation, fitted with a calibrated load indicator and automatic safety override to ensure that the maximum allowable pulling force cannot be exceeded.

7.9.2.3.8 Where a by-pass is used to maintain supplies, consideration should be given to minimising obstruction to pedestrians and traffic and also to protection against damage.

7.9.2.3.9 All PE pipe joints shall be inspected for integrity prior to insertion.

7.9.2.3.10 If a pipe string is pressure tested before insertion, the string should be anchored temporarily to prevent movement and warning signs should be placed at each end of the site.

Consideration shall be given to restrict the passage of pedestrians close to the testing site.

7.9.2.3.11 Consideration shall be given to the insertion of a proving pipe which can then be examined for scoring.

7.9.2.3.12 If the existing pipeline is to be cleaned, any operative working in any of the open excavated areas should be warned and PPE shall be worn. If cleaning of the existing pipeline is required, precautions shall be taken to protect the public from dust and loose material which may be discharged from the pipeline during cleaning operations. Waste filters should be fitted at end of the pipeline.

7.9.2.3.13 Disposal of waste substances from existing pipelines, for example chemical deposits from gas pipelines, deposits from water mains released during cleaning and sewerage effluent from sewer pipes must be in accordance with relevant legislation and should be in accordance with the engineer's requirements.

7.9.2.3.14 Rollers should be used at the launch area, to prevent damage to the new inserted pipe during pull-in.

7.9.2.3.15 When pulling in the pipe, preference should be given to the use of steel wire cable and a current test certificate for the cable should be available.

7.9.2.3.16 The winch shall be fitted with a suitable means of control to limit the pull force applied to the pipe. Consideration should be given to the use of a drop leg capstan and protective spooling drum.

7.9.2.3.17 Any winch shall be anchored securely and, by means of suitable barriers, personnel and public excluded from standing in the direct failure path of the cable or chain. The winch should be fitted with an automatic load limiting device. Protective gloves should be used at all times when working with cable. Timber shoring can be used fitted across the excavated area to protect against cable fly back in the event of a break. Launch pits should be covered with safety mesh. Wherever possible, all exposed winch cables should be contained below ground.

7.9.2.3.18 When using a power operated winch, the operator shall not exceed the pull force specified in the operation method statement specific to the length, nominal diameter and SDR rating of the pipe being inserted. If the tension during the pull rises suddenly, the winch shall be stopped immediately. The tension must be released before any attempt is made to investigate the obstruction.

7.9.2.3.19 If the "push" method is to be introduced, care should be exercised when the free end of the inserted pipe is close to the launch trench as the pipe may whip or bow.

7.9.2.3.20 Operatives at launch and receive pits should maintain contact by radio, if necessary. The pipe being inserted should not be allowed to drag over rough surfaces or sharp edges. Rollers or a coil dispenser should be used to enable the pipe to enter the existing main at a slow walking pace.

7.9.2.3.21 It may be necessary for personnel to enter an excavation to guide the pipe being winched or pushed in order to facilitate entry into the existing pipe. Once this is achieved, personnel should leave the excavation while insertion is in progress and no person should enter the excavation. Where it may be necessary to measure the dimensions of a deformed plastic pipe, only the person measuring the dimensions of the pipe and pushing machine should be allowed to stand at the front of the rig. All other personnel should stand clear of the front of the rig and winch unit while deformation is in progress.

7.9.2.3.22 All equipment anchorage points shall be monitored during the insertion process.

7.9.2.3.23 An "unsafe zone" shall be indicated around the rig and winch unit by use of approved barriers and signs warning no entry.

7.9.2.3.24 Where lubricants, such as oil, are used, a COSHH assessment must be undertaken.

7.9.2.3.25 Operatives shall be aware that exposed sections of the host pipe and equipment may generate significant heat during some reversion processes.

7.9.2.3 *Cured in place pipe (CIPP)*

CIPP is a process that utilises a fabric tube which is impregnated with polyester, epoxy or other resin. The tube is inserted into the existing pipeline and inflated against the pipe wall, then cured either at ambient temperature or by the application of an energizing source such as hot water, steam or ultra-violet light. This creates a close fit lining.

7.9.2.3.1 In addition to the general issues given in Sub-Section 7.9.2, consideration shall be given to the following:

- ensure that only competent, trained personnel experienced in the technique are allowed to undertake the work
- dealing with the transfer of effluent during lining operations
- assess the potential hazards in handling and working with woven tubing, resins, chemical styrene and pre-impregnated linings
- assess the potential hazards of the transportation and storage of resins and other materials
- assess the potential hazards of disposal of surplus resins and other materials
- assess the potential hazards of obtaining water for use in the operations and its disposal after use
- assess the potential hazards of pipeline cleaning using pressure jetting equipment
- working with steam and hot water boilers on site

- assess the potential hazards from steam, hot water and ultra violet light used during the curing process.

7.10 INTERNAL PIPE REPAIR SYSTEMS

7.10.1 General

7.10.1.1 Only competent persons experienced in the techniques shall be allowed to undertake the work. Where personnel will be required to enter and work in the pipeline, consideration should be given to their medical fitness

7.10.2 Operational activities

7.10.2.1 *Communication*

7.10.2.1.1 A full site induction meeting shall be held with all operatives involved with the work before work commences. This should be held by a senior manager in the company and highlight the areas at risk and the safety procedures to be taken.

7.10.2.1.2 All visitors and new members of the site staff shall be safety inducted by the most senior site member before commencing the visit or starting work.

7.10.2.1.3 Prior to commencing any drilling operation, emergency communication methodologies shall be established, agreed and tested.

Note: This will include emergency services, other utilities emergency contacts and other applicable third parties.

Where mobile reception is poor or unavailable, a contingency methodology shall be made available. The competent person shall be responsible for such communication.

7.10.2.2 *Site Preparation*

7.10.2.2.1 Relevant health, safety environmental and statutory documentation shall be available on site and accessible for use by operatives and for inspection by interested parties. These shall cover all equipment and materials used in the process. It should include vessels, winches, cables, lifting equipment, pressure and electrical equipment.

7.10.2.2.2 A comprehensive method statement shall be available before work commences which should detail the safety requirements, such as Permits to Work, gas free certificates etc. Consideration should be given to working within confined spaces and in potentially hazardous atmospheres.

7.10.2.2.3 End restraint and anchorage of the cap ends of exposed live pipelines should be undertaken. Exposed pipe, including bypass connections, should be suitably protected and supported where necessary.

7.10.2.2.4 Analysis of dust and debris shall be undertaken to determine if potentially hazardous substances are present in the main. This will determine the safety considerations required for both handling and disposal of the material and any specific requirements for PPE.

7.10.2.2.5 All loose dust and debris shall be removed and disposed of in a safe and proper manner.

7.10.2.2.6 If water is to be used in the cleaning process this shall be obtained from an approved water supply. Cleaning washings should be collected and disposed of in a safe and proper manner. They shall not be allowed to drain into the ground or watercourses.

7.10.2.2.7 It shall be ensured that the atmosphere in the pipe is safe before employing any pipe preparation techniques which may produce sparks.

7.10.2.3 Repairing

7.10.2.3.1 Communications shall be agreed with personnel on site before work commences. Consideration should be given to additional noise level from operating equipment and machinery and from passing traffic.

7.10.2.3.2 Periodic atmosphere checks shall be made both in the pipe and the excavations with an appropriate approved gas detector.

7.10.2.3.3 All repair materials shall be handled and stored in a safe and proper manner. Spent or surplus sealants shall be disposed of in a safe and proper manner.

7.10.2.3.4 Engineering requirements for re-commissioning the pipeline shall be observed.

SECTION 8 : RECORDS AND REPORTING

8.1 Trenchless techniques generally form part of a larger project and consideration should be given to keeping pre construction and post construction records separate.

8.2 All relevant information having implications for health, safety and the environment, particularly risk assessments, reviews, and monitoring results acquired during the construction operations, should be passed to the CDM Co-ordinator or Principal Contractor, as appropriate, for inclusion in the Health, Safety and Environmental file.

8.3 The administration system for the control of the works and the incorporated safety features should be clearly written down in a concise manner and available for all to see at any time. The recording system should be automatic and include a data logging system where possible. Operators hand-written log sheets should be written in ink and all changes clearly verified and initialled by the supervisor. There should be a section within the driving/drilling log sheet for operator's comments. All log sheets must be incorporated into the Health, Safety and Environmental file including any computer generated information.

8.4 Photographic records should be taken of the structures along the route and where necessary condition or structural surveys undertaken by an independent person and reports provided. This should include full pre-construction pipe inspection recordings where required.

8.5 The location of trial holes should be marked clearly on the site plan.

8.6 The proposed route to the new pipe or repaired services together with the position of the launch/entry and reception/exit points should be recorded on the site plan.

8.7 Statutory records must be kept, where applicable, for certain items of equipment such as lifting gear, fire fighting equipment etc.

8.8 A record should be kept of all complaints received during the works such as noises, vibration, subsidence, heave, cracking, sticking doors, fluid leakage to surface etc. and, these, after investigation should be incorporated into the Health, Safety and Environmental file together with, if possible, the explanation of the occurrence.

8.9 Where CDM apply, a Health, Safety and Environmental File should be prepared at the end of the project. It is the CDM Co-ordinator duty to ensure that the file is prepared and handed over to the client. The client then has a duty to ensure that the file is made available for anyone who needs to see it in order to control risks to his Health, Safety and Environment.

The Health, Safety and Environmental file shall contain information which is relevant to controlling risks to health and safety of anyone who may carry out alterations, maintenance or demolition work on the structure.

The Health, Safety and Environmental file shall include:

- records or as built drawings
- general details of the construction methods and materials used
- details of the structure's equipment and maintenance facilities
- maintenance procedures and requirements for the structure
- operating or maintenance manuals provided by suppliers of specialist machinery
- details on location of utilities and services, including adjacent or crossing services identified during construction.

8.10 Full as-built records shall be provided for the works and incorporated into the Health, Safety and Environmental file and, where available, should include any video/electronic recordings. These records should, where applicable, include any comments made by the machine/plant operator during the construction of the works and should be retained for further reference.

8.11 For pipe cleaning, daily record sheets shall be provided listing the lengths of pipes cleaned by access reference number, details of problems encountered including the maximum pressure used to clear any blockages, weighbridge tickets, disposal records and unit details. Schedules and plans should be returned with this documentation.

SECTION 9 : TRAINING AND ACCREDITATION

9.1 Persons should not operate plant and equipment without understanding fully the scope, purpose and operational characteristics of the particular type of equipment to be used.

9.2 Any person operating plant and equipment, or supervising and planning works, should have undertaken a suitable course of training appropriate to the level of responsibility they would be exercising.

9.3 Training courses should be based on principles of competence and should be undertaken and managed only by approved centres following an industry approved course (in the UK, this would be a UKAS approved centre or similar).

At least one operative on site shall be registered as competent, in the trenchless technique(s) being used, for at least one year.

9.4 Training courses should contain the following elements:

- safety and safety systems
- site selection and environmental impact
- buried plant location
- site preparation
- operational principles and equipment maintenance
- site husbandry
- ground structures and composition
- supervision and management (as appropriate)
- record keeping.

9.5 Individual operators should be certificated for each type of equipment used.

9.6 All training should be carried out in suitable conditions either on or off site as deemed appropriate. Candidates should demonstrate an understanding of the theory and practical side of trenchless operations, where applicable.

Note: This understanding could be confirmed by the candidate completing successfully a practical based assessment and an associated written paper demonstrating an understanding of the theory.

9.7 Organisations engaged in trenchless techniques activities should make provision for regular updating of the training of all personnel regarding new equipment or technological change within the range of trenchless techniques as appropriate to their organisation.

9.8 Specialist HDD contract supervisors shall require training on the inspection and maintenance requirements of the equipment.

9.9 Personnel who have not planned, managed, supervised HDD operations or used the specific equipment they were trained on within a three year period shall undertake refresher training with assessment before being allowed to continue.

9.10 A portfolio of evidence shall be kept by managers, supervisors and operatives as evidence they have undertaken their specific duties and remain updated on new developments and techniques associated with HDD.

9.11 The procedural and technical competencies of individuals engaged in HDD operations to discharge their duties shall be revalidated at the time of their scheduled competency assessment review. Arrangements shall be made with

specialist sub-contractors to demonstrate a similar assessment review for their operatives.

9.12 All personnel working on pipe cleaning or surveying should have been trained for confined space entry and the appropriate units to satisfy the NRSWA.

9.13 Any person operating high pressure water jetting equipment should have been trained on and passed a Water Jetting Association (WJA) approved course, an appropriate City and Guilds certification course or similar.

APPENDIX 1 : GLOSSARY, ACRONYMS AND ABBREVIATIONS

GLOSSARY

drill bit	Device attached to, or an integral part of, a drill string which is used as a cutting tool to penetrate the formation being drilled by the power applied.
drill rig/rig	Machine used in conjunction with the in-hole equipment to carry out directional drilling techniques.

All other definitions are given in IGEM/G/4 which is freely available:

- on a CD, with the purchase of any IGEM Standard, upon request
- by downloading a printable version from IGEM's website www.igem.org.uk.

Recommended and legacy gas metering arrangements are given in IGEM/G/1 which is freely available:

- as a hardcopy, with the purchase of any IGEM Standard, upon request
- by downloading a printable version from IGEM's website.

Downloading from the website ensures access to the latest version.

ACRONYMS AND ABBREVIATIONS

ACoP	Approved Code of Practice
BDA	British Drilling Association
CCTV	closed circuit television
CDM	Construction (Design and Management) Regulations
CIPP	Cured In Place Pipe
CoP	Code of Practice
COPA	Control of Pollution Act
COSHH	Control of Substances Hazardous to Health Regulations
DEFRA	Department for Environment, Food and Rural Affairs
EC	European Community
EHSR	Essential Health and Safety Regulations
EPA	Environmental Protection Act
ERIC	Eliminate, Reduce, Isolate, Control
ERW	electricity resistance welded
FOPS	Falling Objects Protection Structures (ISO 3449)
GB	Great Britain
GPR	ground probing radar
HSWA	Health and Safety at Work etc. Act
HAUC	Highways Authorities and Utilities Committee
HAVS	hand-arm vibration syndrome
HDD	horizontal directional drilling
HMSO	Her Majesty's Stationary Office
HSE	Health and Safety Executive
IGEM	Institution of Gas Engineers and Managers
ISTT	International Society for Trenchless Technology
LFL	lower flammability limit
LOLER	Lifting Operations and Lifting Equipment Regulations
LTEL	long term exposure limit
MAPD	Major Accident Prevention Document
MEG	monoethyleneglycol
MHSWR	Management of Health and Safety at Work Regulations
MOD	Ministry of Defence
MOP	maximum operating pressure
NJUG	National Joint Utilities Group
NORM	Naturally occurring radioactive materials

NRSWA	New Roads and Street Works Act
PE	polyethylene
PPE	personal protective equipment
PRI	pressure regulating installation
PSR	Pipelines Safety Regulations
PSSR	Pressure Systems Safety Regulations
PUWER	Provision and Use of Work Equipment Regulations
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
ROPS	roll over protection structures
SDH	soil displacement hammer
SDR	standard dimension ratio
SSSI	Sites of Special Scientific Interest
STEL	short term exposure limit
SWL	safe working load
UK	United Kingdom
UKSTT	United Kingdom Society for Trenchless Technology
VWF	vibration white finger
WEL	workplace exposure limit
WJA	Water Jetting Association.

UNITS

bar	bar
barg	bar gauge
dB	decibel
Hz	hertz
kV	kilovolt
m	metre
mbar	millibar
mm	millimetre
m min^{-1}	metre per minute
m s^{-2}	meter per second squared
psi	pound per square inch
V	volt

APPENDIX 2 : REFERENCES

The following list, while not exhaustive, gives some of the more important legislation, ACoPs, Guidance and standards that may be applicable in UK. In other countries, reference should be made to the appropriate national legislation.

A2.1 LEGISLATION

- Control of Pollution Act 1974 as amended
- Environmental Protection Act 1990 as amended
- Gas Act 1986, as amended
- Health and Safety at Work etc. Act 1974
- Highways Act 1960 as amended
- New Roads and Street Works Act 1991 as amended
- Noise and Statutory Nuisances Act 1993
- Traffic Management Act 2004
- Utilities Act 2000
- Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 as amended
- Confined Spaces Regulations 1997
- Control of Noise at Work Regulations 2005
- Control of Vibration at Work Regulations 2005
- Construction (Design and Management) Regulations 2007
- Construction (Head Protection) Regulations 1989
- Control of Substances Hazardous to Health Regulations 2002, as amended
- Electricity at Work Regulations 1989
- Environmental Protection (Duty of Care) Regulations 1991
- Health & Safety (First Aid) Regulations 1981
- Lifting Operations and Lifting Equipment Regulations 1998
- Management of Health and Safety at Work Regulations 1992
- Manual Handling Operations Regulations 1992
- Personal Protective Equipment at Work Regulations 1992
- Pipelines Safety Regulations 1996
- Pressure Systems Safety Regulations 2000
- Provision and Use of Work Equipment Regulations 1998
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995
- Street Works (Northern Ireland) Order 1995
- Supply of Machinery (Safety) Regulations 1992
- Town and County Planning (Environmental Impact Assessment) Regulations 1999 as amended.

A2.2 DIRECTIVES

- ATEX Directive 94/9/EC.

A2.3 HSE APPROVED CODES OF PRACTICE AND GUIDANCE

- HSL5 Control of Substances Hazardous to Health. ACoP & guidance to COSHH Regulations 2002
- HSL21 Management of Health and Safety at Work Regulations 1999. Guidance
- HSL22 Safe Use of Work Equipment Regulations. Guidance
- HSL23 Manual Handling. Manual Handling Operations Regulations 1992. Guidance
- HSL25 Personal Protective Equipment at Work Regulations 1992. Guidance
- HSL73 A Guide to Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995. Guidance
- HSL101 Safe Work in Confined Spaces. Confined Spaces Regulations 1997
- HSL108 Controlling Noise at Work – Guidance on the Control of Noise at Work Regulations 2005
- HSL113 Safe use of lifting equipment – Lifting Operations and Lifting Equipment Regulations 1998 – ACoP and Guidance
- HSL122 Safety of pressure systems. Pressure Systems Safety Regulations 2000. ACoP
- HSL130 The compilation of safety data sheets. Chemicals (Hazard information and packaging for supply) Regulations 2002 ACoP
- HSL140 Control of Vibration at Work Regulations 2005. Guidance.
- HSL144 Managing Heath and Safety in Construction – Construction (Design and Management) Regulations 2007 - ACoP
- HSG47 Avoiding Danger from Underground Services
- HSG48 Reducing Errors and Influencing Behaviour
- HSG51 Storage of Flammable Liquid in Containers
- HSG53 Selection, Use and Maintenance of Respiratory Protective Equipment
- HSG65 Successful Health and Safety Management
- HSG85 Electricity at Work Safe Working Practices
- HSG137 Health Risk Management. A Practical Guide for Managers in Small and Medium Sized Enterprises (1995)
- HSG149 Backs for the Future – Safe Manual Handling in Construction
- HSG150 Health and Safety in Construction
- HSG170 Vibration Solutions 1997
- HSR25 Electricity at Work Regulations. 1989. Guidance
- HS EH40 Workplace exposure limits
- INDG 136 Working with substances hazardous to health
- INDG 178 Written Schemes of Examination. Pressure Systems Safety Regulations 2000
- INDG 229 Using work equipment safely
- INDG 261 Pressure systems – safety and you
- INDG 291 Simple guide to the Provision and Use of Work Equipment Regulations
- HSC 13 Health and Safety Regulations – A Short Guide

- GS6 Avoidance of Danger from Overhead Electrical Lines.

A2.4 **IGEM**

- IGEM/TD/1 Edition 5 Steel pipelines for high pressure gas transmission
- IGE/TD/3 Edition 4 Steel and PE pipelines for gas distribution
- IGE/TD/4 Edition 4 PE and steel gas services and service pipework
- IGE/SR/10 Edition 2 Dealing with escapes of gas into underground plant
- IGE/SR/18 Edition 2 Safe Working in the vicinity of gas pipelines and associated installations
- IGE/SR/24 Risk assessment techniques
- IGEM/GL/6 Edition 2 Permitry for the safe flow of gas
- IGE/GL/8 Edition 2 Reporting and investigation of gas related incidents
- IGEM/GL/4 Edition 2 Gas system assets - risk management.

A2.5 **BRITISH STANDARDS (abbreviated titles)**

- BS 5228 Noise and vibration control
- BS 6164 Code of practice for safety in tunnelling
- BS EN 791 Drill Rigs safety
- BS EN 982 Safety of machinery-fluid powers (hydraulics)
- BS EN 983 Safety of machinery-fluid powers (pneumatics)
- BS EN 13510 Roll Over protection structures
- BS EN 60204 Safety of machinery-electrical equipment
- BS EN ISO 12100 Safety of machinery
- BS EN ISO 14001 Environmental management systems

A2.6 **INTERNATIONAL STANDARDS (abbreviated titles)**

- BS EN ISO 3471-1 Earth moving machinery: Roll over protection structures
- BS EN ISO 3449 Falling objects protection structures
- BS EN ISO 3457 Earth moving machinery: Guards and shields
- BS EN ISO 5349 Guidelines for Assessment of exposure to hand transmitted vibration
- BS EN ISO 8041 Human Response to vibration - measuring instrumentation
- BS EN ISO 14121 Safety of machinery-risk assessment

A2.7 **CODES OF PRACTICE**

- Codes of Safe Drilling Practice – Published by BDA
- Guidance Notes for the Safe Drilling of Landfills and Contaminated Land – Published by BDA
- Code of Practice for Safe Concrete Drilling and Sawing – Published by the

Drilling and Sawing Association

- High and Ultra High Pressure Water Jetting – Code of Practice Published by the Water Jetting Association
- For Safe Working and use of Water Jetting in Drains and Sewers - Code of Practice Published by the Water Jetting Association
- Sewer Jetting – Code of Practice published by WRc
- UKLPG CoP 24 – Storage of LPG
- Guidance Notes for the Protection of Persons from Rotating Parts and Ejected or Falling Material involved in the drilling process (August 2000) – published by BDA
- Safety at Streetworks and Road Works – A Code of Practice 2nd Ed 2002.

A2.8 NATIONAL JOINT UTILITIES GROUP PUBLICATIONS

- NJUG Volume 1 Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus
- NJUG Volume 4 Guidelines for the planning, installation and maintenance of utility services in proximity to trees.

A2.9 OTHER REFERENCE DOCUMENTS

- Damage Control Procedure for Pipeline Construction involving Pipe Splitting UKWIR/Transco
- A Guide to Sewerage Operational Practices (Section C2)
- Model Contract Document for Sewer Condition Inspection WSA/WRc May 1994
- Manual of Sewer Condition Classification – 4th Edition WRc 2004
- Recommendations for the protection of diesel engines operating in hazardous areas OCMA MEC1
- Sewerage Risk Management - Sewerage Rehabilitation Manual – 4 Edition WRc developed from April 2001 (only available on CD)
- Trenchless Technology Guidelines. ISTT 1999.

APPENDIX 3 : REFERENCE ORGANISATIONS

A3.1 ORGANISATIONS PROVIDING SAFETY INFORMATION

- British Standards Institution, 389 Chiswick High Road, London, W4 4AL.
  Tel. No: 020 8996 9000
  Web Site: www.bsi-global.com
- Confederation of British Industry, Centre Point, 103 New Oxford Street, London, WC1A 1DU.
  Tel. No: 020 7379 7400
  Web Site: www.cbi.org.uk
- Health and Safety Executive, any local offices of HSE or,
  Tel. No. 0541-545500 (information line)
  Web Site: www.hse.gov.uk
- Institution of Occupational Safety and Health, The Grange, Highfield Drive, Wigston, Leicester, LE18 1NN.
  Tel. No: 0116 257 3100
  Web Site: www.iosh.co.uk
- National Examination Board in Occupational Safety and Health, NEBOSH House, The Grange, Highfield Drive, Wigston, Leicester, LE18 1PP.
  Tel. No. 0116 288 8858
  Web Site: www.cdc.gov.uk/niosh
- Noise Abatement Society, Suite 2, 26 Brunswick Terrace, Brighton, East Sussex BN31 1HJ
  Tel. No: 01273 823 850
  Web Site: www.noiseabatementsociety.com
- Royal Society for the Prevention of Accidents, Edgbaston Park, 353 Bristol Road, Edgbaston, Birmingham B5 7ST.
  Tel. No. 0121 248 2000
  Web Site: www.rospa.co.uk

A3.2 SOURCES FOR SAFETY INFORMATION – DRILLING RELATED

- British Drilling Association Ltd., Wayside, London End, Upper Boddington, Daventry, Northants, NN11 6DP.
  Tel. No: 01327 264622
  Web Site: britishdrillingassociation.co.uk
- Drilling and Sawing Association, Unit 3, Brand Street, Nottingham NG2 3GW.
  Tel No: 01159 867029

A3.3 OTHER SOURCES OF REFERENCE

- British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham, NG12 5GG
  Tel. No: 01159 363100
  Web Site: www.bgs.ac.uk
- ISTT, 15 Belgrave Square, London, SW1X 8PS,
  Tel. No: 020 7259 6755
  Fax: 020 7235 6976
  Web Site: www.istt.com
- National Joint Utilities Group, 111 Buckingham Palace Road, London, SW1 0SR.
  Tel. No: 020 7963 5720
  Web Site: www.njug.org.uk

- National Sewerage Association, 42 Manor Drive North, New Malden, Surrey, KT3 5NY.
  Tel. No: 020 33 00123
  Web Site: www.sewerage.org
- UKSTT, 38 Holly Walk, Leamington Spa, Warwickshire CV32 4LY
  Tel. No: 01926 330 935
  Web Site: www.ukstt.org.uk
- Water Jetting Association, PO Box 59451, London. SE2 8AL
  Tel. No: 02083 115508
  Web Site: www.waterjetting.org.uk
- WRc, Frankland Road, Blagrove, Swindon, Wiltshire, SN5 8YF.
  Tel. No: 01793 865000
  Web Site: www.wrcplc.co.uk

APPENDIX 4 : TRENCHLESS TECHNIQUES, HAZARDS AND MODEL RISK ASSESSMENT

A4.1 TRENCHLESS TECHNIQUES RIG HAZARDS

The following list of hazards has been extracted from European Standard in support of any Risk Assessment Exercise.

A4.1.1 Mechanical hazards

- drawing in or trapping
- high pressure fluid ejection
- ejection of parts
- falling objects
- loss of stability
- slip, trip or fall.

A4.1.2 Electrical hazards

- electrical contact - direct
- electrical contact – indirect.

A4.1.3 Thermal Hazards

- hot surfaces
- cold surfaces.

A4.1.4 Noise Hazards

- from equipment prime mover
- from working process.

A4.1.5 Hazards generated by vibration

- from prime mover
- from working process.

A4.1.6 Hazards generated by materials and substances processed, used or exhausted

- harmful exhaust emissions
- harmful dust emissions
- ejection of material from auger
- fire risk
- use of soil conditions - see Table 2.

MATERIAL	TYPICAL USE	POSSIBLE HAZARDS
Bentonite: Sodium, Potassium, Calcium Montmorillonite	As a slurry in slurry shields and to modify the soil in EPB machines. As a ground support and lubricating medium round jacked pipes and in tunnel boring machines.	Respirable dust in dry state. Slippery when wet.
Polymers: Polyacrylamides Polyacrylates Carboxymethyl cellulose Natural starch Guar	Additives to bentonite to modify viscosity. Lubricant	Generally predicted to be of low health hazard.
Foams and Foaming Agents: Synthetic Foams containing Synthetic detergents Glycol ether foam booster Fluorocarbon (performance enhancer) Protein Foams containing Protein foaming agent Glycol based foam booster	For modifying soils to improve handling characteristics.	Harmful Irritant
Other Materials: Glycol Products Soda ash Lime and Cement Lignosulphonates and Complex Phosphates		 Harmful, irritant Irritant Irritant No information

TABLE 2 : HAZARDS FROM SOIL CONDITIONERS

A4.1.7 **Hazards generated by neglecting ergonomic principles**

- intended use
- Falling objects protection structures (FOPS)
- Roll over protection structures (ROPS)
- controls
- visibility
- lighting.

A4.1.8 **Hazards caused by failure of the energy supply, breaking down of machinery parts and other functional defects**

- failure of energy supply
- failure of control systems
- unexpected loss of machine or equipment stability
- failure of brakes
- failure of wire ropes, roller and leaf chains.

A4.1.9 **Hazards caused by missing and incorrectly positioned safety related measures and means**

- all kinds of guards
- safety related devices

- start and stop devices
- safety signs and labels
- emergency stops and safety devices
- information manuals
- moving parts involved in the working process.

The preceding list of hazards were identified by Risk Assessment significant to trenchless techniques. They all require some form of action to eliminate or reduce risk.

In addition to the hazards listed above, potential hazards from operational modes of the trenchless technique equipment need to be taken into account including:

- transporting to and from the job site
- rigging and dismantling on job site
- operational activity and maintenance on job site
- moving between operational positions on job site
- out of service on job site
- storage at plant depot on job site.

A4.1.10 **Hazards related to operating modes of the varied trenchless techniques**

- machine or equipment tipping or sliding
- leakage of fuel, oil, coolant, hydraulic fluid etc.
- accidental falling of pieces of equipment
- ejection of material from auger and cleaning of auger
- loss of hydraulic or pneumatic power
- electric shock, contact with:
  - overhead power line
  - underground power line
  - accidental exposure to live parts of the equipment.
- mechanical failure or malfunction of components or equipment
- unprotected moving parts of equipment
- exposure to hot or cold component
- whipping of wire ropes and hoses
- high pressure fluids
- excessive vibrations transmitted to personnel
- inadequately guarded accesses and positions
- accesses and positions rendered slippery
- exposure to excessive noise
- deteriorated working environment:
  - due to weather (rain, ice, storms etc.)
  - working ground (mud, water, silt etc.).
- uncontrolled slewing or moving of the rig
- exposure to unhealthy concentrations of dust and toxic gases
- risks during erection and dismantling of masts and feed beams
- fire
- inadequate lighting
- falls from elevated positions

- exposure to battery electrolyte
- explosion due to contact with gas main or ground emanating methane
- moving parts involved in the working process
  - adding and retrieving of augers
  - breaking of threaded connections of equipment
  - handling of components
  - supervision of the operation
  - changing of equipment.

A4.2 RISK ASSESSMENT

A4.2.1 Establishing the risk rating

A4.2.1.1 The following parameters need be established and then applied to the risk rating formula.

$$\text{Risk rating} = \frac{AxB}{C}$$

- **Probable frequency (A)**

  The probability that a circumstance will occur which would lead to an incident or accident if no precautions were in place.

A	Probability of occurrence	Frequency
1	Highly Improbable	1 in 100 years
2	Improbable	1 in 10 years
3	Occasional	Annually
4		Monthly
5		Weekly
6		Daily

- **Severity (B)**

  The potential extent of the resulting incident in terms of severity and numbers involved.

B	Potential extent of incident
1	Trivial
2	Minor
3	Major injury to one person
4	Major injury to several persons
5	Death to one
6	Multiple deaths

- **Reduction factor (C)**

  A factor by which a procedure or precaution reduces the likelihood of an accident or incident occurring. Its application is dependent upon the continuing existence and adoption of those procedures/precautions.

C	Level of reduction
1	Low reduction
2	Low reduction
3	Average reduction
4	High reduction
5	Very high reduction

To establish a risk rating, insert the suggested values into the risk rating formula.

Note: The risk rating lies within the range of 0.2 (the lowest risk) and 36 (the highest risk).

A4.2.1.2 Once a risk rating has been calculated, the next step is to establish a cut-off value above which residual risks are not acceptable.

Note 1: Practice has shown that this is, normally, in the order of 3.8 to 4.0 for most operations. However, this cut-off figure should be evaluated regularly on the basis of historical circumstances

Note 2: Generally, this risk assessment programme follows the recommendations of BS EN 1050. The numbers have no meaning other than as a comparative assessment of the severity of the risk.

A4.2.2 **Simplified risk assessment**

The main purpose of risk assessment is to identify the risk relating to a particular activity. Subsequently, the risk can be reduced to an acceptable level. A simplified table relating to a single task is shown below. Other hazards may be identified for this activity.

Hazard Identified	Frequency A	Extent B	Precautions in place	Reduction C	Risk rating	Additional precautions
Condition of vehicle **Target date: ongoing**	2	2	Regular Maintenance	5	0.8	None
Driving skill **Target date: ongoing**	3	1	Use approved drivers only	4	0.7	None
Weather conditions **Target date: ongoing**	4	2	Use approved drivers only	4	2.0	None

TABLE 3 - RISK ASSESSMENT FOR TRAVELLING TO SITE

APPENDIX 5 - EXAMPLE OF PRE-MOLING CHECKLIST

PRE-MOLING CHECKLIST	SAFE TO CONTINUE YES/NO
Have you undertaken a site-specific risk assessment?	
Have you studied and understood the utility drawings provided?	
Have you checked for visual indications of buried services?	
Have you traced the entire area to be moled, using the CAT & Genny on Power, Radio and Genny Modes?	
Have you used the plug connector to trace the electricity service from the property to the main?	
Have you used the street light clamp to trace the street lighting cable?	
Have you excavated on and exposed all buried utilities on site including electric, gas, street lighting, cable TV, BT, water, street furniture etc.?	
Have you excavated and exposed the entire route in the footpath that will be affected by the route of the mole?	
Have you identified a safe moling route leaving at least 300 mm clearance from parallel electric cables and 250 mm clearance from other parallel services?	
Have you identified in which direction to mole, i.e. towards the lowest risk area?	
Do you have all appropriate PPE and are you wearing it?	
Have you accurately marked the distance to be moled on the mole hose?	

APPENDIX 6 - EXAMPLE OF PRE-BURSTING CHECKLIST

PRE-BURSTING CHECKLIST	SAFE TO CONTINUE YES/NO
Have you undertaken a site-specific risk assessment?	
Have you studied and understood the utility drawings provided?	
Have you checked for visual indications of buried services?	
Have you traced the entire area of work using the Cat and Genny on Power, radio and Genny modes?	
Have you used the plug connector to trace the electricity service from the property to the main?	
Have you used the street light clamp to trace the street lighting cable?	
Have you excavated on and exposed all buried utilities on site including electric, gas, street lighting, cable TV, BT, water, street furniture etc.?	
Have you excavated and exposed the entire route in the footpath that will be affected by the route of the mole?	
Have you identified all plant running parallel to the main, confirming at least 300 mm clearance from parallel electric cables and 250 mm clearance from other parallel services?	
Do you have all appropriate PPE and are you wearing it?	

APPENDIX 7 : PERMIT TO DRILL

PERMIT TO DRILL

PART A - PROJECT DETAILS **Project No:**

Location: _

Instructions: _

Bore Length: m | **Proposed depth:** m | **Final Bore Diameter:** mm

Limit of permit (state accordingly, e.g. house, number, lamp post numbers, road junctions, etc.):
From: **To:**

Date of permit:
From: **To:**

PART B - SITE PROTECTION

Traffic management (describe, e.g. traffic lights, road closures, lane closure, priority signs, etc):

Protection (describe, e.g. crowd barriers, fencing, barrier boards, etc):

PART C - UNDERGROUND SERVICES /STRUCTURES

Drawings requested and available on site – (insert YES, NO or N/A)

	GAS Incl. HP	ELECTRICITY Incl. M & HV	WATER	TELECOM	SEWERAGE (incl: pumped)	OIL	NAT GRID	OTHER Gas Transp.	STRUCTURES	OTHER (specify)
Requested										
Available on site										
Which services / structures have been exposed by hand to 250 mm below their inverts? (✓)										
Which services/structures have been clearly marked? (✓) If not exposed indicate why in Part E below										

An adequate sketch plan showing all services / structures identified along / close to the line of the bore **must** be attached to this "permit to drill". **ATTACHED?** (circle) **YES/NO**

PART D - CONTAMINATED LAND

Is the work to be carried out in areas known to contain contaminated land? (circle) **YES/NO**

If YES, have all site personnel received instruction for working in these areas? (circle) **YES/NO**

PART E – OTHER MATTERS

Specify any other matters of relevance to all operatives on site:

PART F – AUTHORISATION AND ACCEPTANCE

To be completed by Responsible Person:

I confirm that I have inspected this site and am satisfied that this drilling operation can proceed.
Name: (print) Signed: Date:

To be completed by Competent Person AND Drill Rig team leader:

We confirm that the drawings referred to above are available on site, that we have examined them, inspected the site of works and that to our knowledge the above represents a complete and accurate statement of the proposed works.
CP Name: (print) CP Signed: Date:
DR Name: (print) DR Signed: Date:

APPENDIX 8 – HIGH PRESSURE CLEANING

This technique is not recommended for use in the cleaning of gas mains.

General

- ascertain the nearest designated hydrant in relation to the location of the work and allow adequate time for filling the vehicle with water
- on arrival on site, establish a line of communication that is a mobile telephone, two way radio or private mobile radio. Where appropriate, use intrinsically safe equipment
- ensure any vehicle is parked so that ignition risks from possible gas escape are minimised
- erect signs as required in accordance with "Safety at Streetworks and Roadworks" (CoP) having due regard for the safety of the public. Pay special attention to local conditions, for example hospitals, schools, disabled or blind persons
- ventilate the pipeline for a minimum of 20 minutes (after lifting the last access point cover) using natural ventilation or as appropriate for the structure
- lift access point covers as a two person operation with a coordinated lift or a one man operation with a suitable cover-lifting device. Twist unattended covers 45^{O} and rest them on their frames
- insert an appropriate approved gas monitor on a line to test the atmosphere at the pipe level where the access point cover has been raised
- note any unusual smells and visually check for any hazards or adverse conditions that may present risks to the crew or equipment, especially the stability of the structure (including ladders or step irons)
- if the gas test exceeds the limits set in the risk assessment, carry out further gas tests to determine that it is safe to proceed. If the gas test continues to register adverse risks, immediately report the matter to the client and abandon the operation
- if entry is required, wear safety harnesses, lines and escape sets and make the hoist ready, if appropriate. Ensure breathing apparatus and resuscitator equipment is to hand
- complete the Confined Space Entry Log
- if the gas test is within acceptable limits as set out in the risk assessment, enter the confined space only in accordance with the procedures and training given. Continue to monitor for gas for the duration of the work
- ensure that a top person is in attendance above the access point at all times while there is a person below setting up/dismantling equipment. Ensure the person below remains attached to the hoist safety rope at all times during the entry and, in the event of the gas detector alarming or the person feeling unwell or detecting unusual odours, vacate or winch the person from the access point. Don the escape set. Rescue procedures must be carried out strictly in compliance of confined space training
- lower the appropriate equipment into the pipeline, align and make any additional settings. Under normal circumstances, do not switch on the equipment until the access point has been vacated
- set and adjust the top and bottom protective sleeve (as appropriate) to ensure the cable is protected while in operation and the vacuum head set as required by the conditions
- carry out jetting in accordance with the specification and quality procedures to achieve the required standard of workmanship. Adjust, re-set or replace equipment as necessary to achieve the required standard in difficult conditions. If equipment is unable to complete the task, the work may have to be abandoned
- continue the cycle of work, until the jetting head either reaches the access point or the work has to be abandoned because access or the condition of the pipeline is such that the work cannot continue.

Manning Levels

- ensure a crew strength of at least two persons, having due regard both for confined space entry and working procedures. Additional persons will be required where the dump or dry shut off valve is remote from the operator controlling the jet (to assist with handling the hose if it is too long or too heavy for one operator or to maintain communication between the hose operator and the pump unit operator when they are out of sight of each other). Awkward access to entry points and problem traffic areas may also require additional persons
- a single person operation is permissible in circumstances where it is clearly demonstrated that there is no increased risk to the operator and third parties, having undertaken a full assessment of all those risks. Use adequate remote control system with fail safe provision to control both the jetting operation and the pump during all single operations
- where certain jobs are identified as having a greater than normal safety risk, carry out the work as detailed in the method statement which clearly identifies hazards and risk and the proposed method for dealing with the problem. A Permit to Work System may be required for confined spaces operations.

Hazards and precautions additional to those in water jetting

Abrasive jet cutting techniques, which may be used for cutting most materials and compositions, are suitable for use in areas where conventional cutting equipment would be unacceptable due to the risk of sparks.

- prior to any cutting, check the pipe to confirm that it is no longer live and/or confirm the contents of the pipe to prevent the uncontrolled release of contents
- ensure operators are specially trained in the use of the equipment
- provide protection for components or structures within range of the cutting jet and ricochet of abrasive particles
- assess changes in the structural integrity of the item/structure being cut and provide suitable supports where necessary, including the safe retention/handling of cut items, as the process continues
- position equipment to allow for the safe manual or mechanical handling of abrasives
- take account of the increased loads likely to be imposed on the structure being cut by the retained water/abrasive mix
- use a remote control nozzle handling system, where practical
- earth equipment to meet the ambient requirements
- consider COSHH assessments on the abrasive used and on the resulting debris
- comply with CDM Regulations where applicable
- ensure pressure vessels are certificated
- ensure uniform particle size and freedom from foreign material, to prevent system blockages
- when using venture systems or high or ultra high pressure, take care in the selection of sufficiently fine grades of material to avoid blockages and excess wear
- do not use material containing fine silica.

Site clearance

- on completion of the work, replace all covers, pack equipment away, remove road cones and signs and leave the site left in a safe condition
- take special care in the cleaning and maintenance of equipment, due to the presence of abrasive in the operating area
- abrasive and other residues may contain toxic or noxious substances resulting from the cutting process. Exercise due care in the disposal of these residues in accordance with the Environment Policy

- ensure that tipping is only carried out at the designated local disposal site. Give attention to the appropriate technical instructions from the Company and/or the disposal site. Retain any paperwork issued
- at the end of the working shift:
    - check that all equipment is in sound working condition and carry out routine maintenance tasks
    - report any defects, operational problems or faults not already notified to the depot or client, as appropriate
    - confirm the completion of the shift.

APPENDIX 9 – PIPE INSPECTION

General

- where certain jobs are identified as having a greater than normal safety risk, work must be carried out in accordance with the method statement, which clearly identifies hazards and risks and the proposed method for dealing with the problem. Make specific reference to hazards and the precautions associated with pressured systems; live gas main operations and working in confined spaces
- in general, carry out work in accordance with permits to work, method statements or specifications and any locally-notified requirements
- where appropriate, use intrinsically safe equipment.

Site operations

- on arrival on site, establish a line of communication, for example using mobile telephones, private mobile radio or two way radio
- take care in parking the vehicle to ensure that ignition risks from possible gas escape is minimised
- erect barriers and signs as required in accordance with "Safety at Streetworks and Roadworks" (CoP) having due regard for the safety of the public. Pay special attention to local conditions, for example hospitals, schools, disabled or blind persons
- remove any inspection cover for access and ventilation. Where access to the pipe is required within an excavation, establish safe access and egress for personnel. The lifting of covers is a two person operation with a coordinated lift or a one person operation with a suitable lifting device. Twist unattended covers 45^{o} and rest on their frames
- insert an appropriate approved gas monitor on a line to test the atmosphere at the pipe level where the entry point access cover has been raised and at the mid and lower point of any confined space
- during the gas test, note any unusual smells and visually check for any hazards or adverse conditions that may present risks to the crew or equipment, especially the stability of the excavation or structure including ladders or step irons
- if the gas test exceeds the limits set in the risk assessment, open other covers to ventilate the line and carry out further gas tests to determine that it is safe to proceed. Where the gas test continues to register adverse risks, report the matter immediately to the client and abandon the survey
- if manned entry is not required, make ready the camera, tractor assembly, and equipment winch or appropriate lowering equipment
- if the gas test is within acceptable limits, as set in the risk assessment, in respect of an explosive or toxic atmosphere, lower the CCTV equipment into place using the winch or appropriate lowering equipment in accordance with the operating procedures and the training given, while continuing to monitor for gas for the duration of the survey
- if manned entry is required, wear safety harnesses, lines and escape sets and breathing apparatus and make the hoist ready, if appropriate. Ensure breathing apparatus and resuscitators are to hand. Ensure one person in the team is an appointed first aider, trained in resuscitation techniques
- complete the Confined Space Entry Log
- İf the gas test is within acceptable limits, as set in the risk assessment, in respect of an explosive or toxic atmosphere, enter the confined space in accordance with the procedures and training given. Continue to monitor for gas for the duration of the survey
- ensure a top person is in attendance above the access point at all times while there is a person below setting up/dismantling equipment. In the event of the gas detector alarming or a person feeling unwell or detecting unusual odours, vacate or winch from the access point. Don escape breathing apparatus. Ensure the top person continually observes the person below and winch them out should they appear to be in difficulty or be unable to communicate. The second top person must be in the vicinity to assist the top person while

a person is below. The person below should remain attached to the hoist safety rope at all times during the entry

- survey in accordance with the specification and quality procedures
- on completion of the operation, replace all covers etc., remove barriers and leave the site in a safe condition.

Site clearance

At the end of the working shift, the following should be carried out:

- check and stow safely all cameras and associated equipment
- report any defects, operational problems or faults not already notified to the manager
- confirm the completion of the shift.

Manning levels

- ensure the absolute minimum crew strength is two persons, having due regard both for confined space entry and working procedures. Additional persons will be required where the access point is side entry or offset, where the access is staged and where the depth exceeds 9 m. For manual inspections involving a working party "walking through" the manning level will depend upon the circumstances and site conditions giving due regard to local hazards, communications between top person and working party, security of the site and escape routes. Awkward access to entry points and problem traffic areas may also require additional personnel
- in all cases, agree the manning level with the Health and Safety Manager or person nominated to deputise for him in his absence, preferably at quotation stage and certainly before any work commences.

APPENDIX 10 – BLAST CLEANING OPERATIONS

Equipment

- ensure those who operate equipment are adequately trained and proven competent. Ensure that all equipment is in good working order and used in accordance with the manufacturer's instructions and recommendations
- do not, normally, exceed an air supply pressure of 7 bar to the blast cleaning machine. Fit an excess flow valve at the inlet end of the compressed air hose to shut off the flow of air in the event of a hose rupture or of a coupling failing. Include a liquid separator (knock-out-pot) as an integral part of the air inlet to the blast cleaning machine
- make the blast cleaning hose, where reasonably practicable, a single continuous length with suitable end couplings. Conforming to current standards and manufactured from anti-static material
- install a quick fail-safe control (dead man's handle) at the nozzle to allow the blast cleaning operator to have direct control of the flow of abrasive. Securely fasten the control line to the 'dead man's handle' to the blast cleaning hose at intervals of approximately 1 m
- ensure the hose supplying breathing air to the blast cleaning operator's helmet complies with current legislation with respect to resistance to kinking, strength, flexibility, cleanliness and leak tightness etc. and is only used for the supply of breathable air. Ensure the length of the hose is not less than 9 m or more than 23 m and should not be capable of being interchanged with the blast cleaning hose
- preferably use an air blower/turbine driven by a compressed air motor to provide the breathing air supply and adequately protected the air inlet from extraneous matters. When these mobile compressors driven by internal combustion engines are used, they should incorporate effective air purification systems in compliance with the appropriate standards.

Site preparation

- ensure the working area is adequately lit by appropriate lighting equipment
- make the working area of sufficient size to allow the blast cleaning operator and assistant adequate room to carry out the work and manoeuvre with their equipment without interference from pipes, fittings etc.
- erect barriers and signs as required in accordance with "Safety at Streetworks and Roadworks" (CoP) having due regard for the safety of the public. Pay special attention to local conditions, for example hospitals, schools, disabled or blind persons
- display appropriate notices to warn of:
  - blast cleaning operations
  - the need to wear or use appropriate PPE.
- maintain safe means of access and egress at all times. Where work is to be carried out within a confined space, at a high level or in some other potentially dangerous place, put risk assessments in place to ensure that all necessary precautions have been taken
- wherever practicable, erect screens prior to blast cleaning to ensure that people, vehicles and property are protected and that abrasive materials and airborne debris are confined to a limited area. Consider eliminating potential traps where the spent abrasive could be difficult to retrieve
- adequately mask equipment and/or apparatus which is liable to be damaged, before the commencement of any blast cleaning operation.

Typical areas to be masked include:

- fire protection equipment
- atmosphere sensing heads
- control equipment vents
- closures
- lubrication points

- spray heads
- flame traps
- open flange joints
- name plates
- lagged areas.

Surface preparation

- establish, as far as is practicable, visually and by scraping, that the surface is not severely corroded and/or graphitized before any form of surface preparation is commenced. During the initial inspection of the surface, wear approved eye protection. There is a variety of methods of surface preparation including scraping, wire brushing, needle gun and strap cleaning. Where considered appropriate, use anti-spark tools. Wear appropriate PPE in all cases
- blast cleaning should not be carried out if the surface is found to be severely corroded and/or graphitized.

Site operations

- carry out all blast cleaning operations in accordance with the authorisation procedures, for example Permits to Work etc., which may be applicable in the particular circumstances
- stand the blast cleaning equipment apparatus on firm ground, upwind of the blast cleaning operation. Securely anchor any excessive length of blast cleaning hose, where reasonably practicable
- where the work is being undertaken in an area deemed hazardous by the risk assessment, locate the compressor in a safe area. When this is not feasible, ensure the air compressor complies with the recommendations given in MEC-1 or equivalent, as a minimum. Note that, where Natural Gas is the hazard, an engine and exhaust system surface temperature to a maximum of 450°C is acceptable
- ensure any air compressor not complying with the recommendations in MEC-1 or equivalent, as a minimum, incorporates the following when operating in a hazardous area:
  - the compressor hose, blast hose and pipework etc. should all be bonded together using flexible copper braid secured with clamps and effectively earthed
  - the diesel engine should be fitted with a suitable flame arrestor on the exhaust pipe and an overspeed cut-out device to isolate the air supply.
- agree communications with personnel on site before work commences, particularly between the operator and assistant
- if gas is present within the working area, monitor the concentration and have it evaluated by a person competent to do so, using appropriate gas detection equipment. Keep all sources of ignition out of the working area
- prior to commencing blast cleaning operations, reduce any gas escaping and maintain at a level not exceeding that which is normally designated as a 'weep' i.e. that which produces small foaming bubbles when leak detection fluid is applied

  If the leak cannot be maintained at this level, carry out the work under the direct control of a responsible engineer who should take whatever action is necessary to ensure that the operation is undertaken in a safe manner.

  If leaks are detected on gas pipes operating at pressures above 2 bar, stop the work immediately and advise the responsible engineer.
- wear personal protective equipment at all times while blast cleaning is in progress and, also, whilst the blast cleaning machine is being filled with abrasive. Use respiratory protective equipment in accordance with established safety guidelines
- where the breathing air is supplied from an air blower/turbine, locate the air inlet up-wind of the compressor in the air free from contamination by flammable gas, grit, diesel, engine exhaust fumes etc.

- direct the nozzle away from any person and towards the object to be cleaned in such a manner as to minimise the migration of abrasive from the working area
- during blasting cleaning operations, ensure the assistant keeps a watch on the operator and is prepared to shut down the blast cleaning machine in an emergency.

Manning levels

- perform blast cleaning operations at all times by a minimum of two persons (the operator and an assistant) both of whom should be capable of carrying out their respective operational duties
- perform any blast cleaning operation under the control and supervision of a person competent to direct such operations. The operator may undertake supervision of operations, provided they are competent to do so.

Site clearance

- exercise special care in the cleaning and maintenance of equipment due to the presence of abrasive in the operating area
- blow all hoses through to remove any dirt and fluid. Remove spent abrasive and debris
- abrasive and other residues may contain toxic or noxious substances resulting from the process. Exercise due care in the disposal of these residues in accordance with the Environment Policy
- ensure tipping is carried out at the designated local disposal site. Give attention to the appropriate technical instructions from the Company and/or the disposal site. Retain any paperwork issued
- at the end of the working shift:
  - check that all equipment is in sound working condition and carry out routine maintenance tasks
  - report any defects, operational problems or faults not already notified to the depot or client, as appropriate
  - confirm the completion of the shift.

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