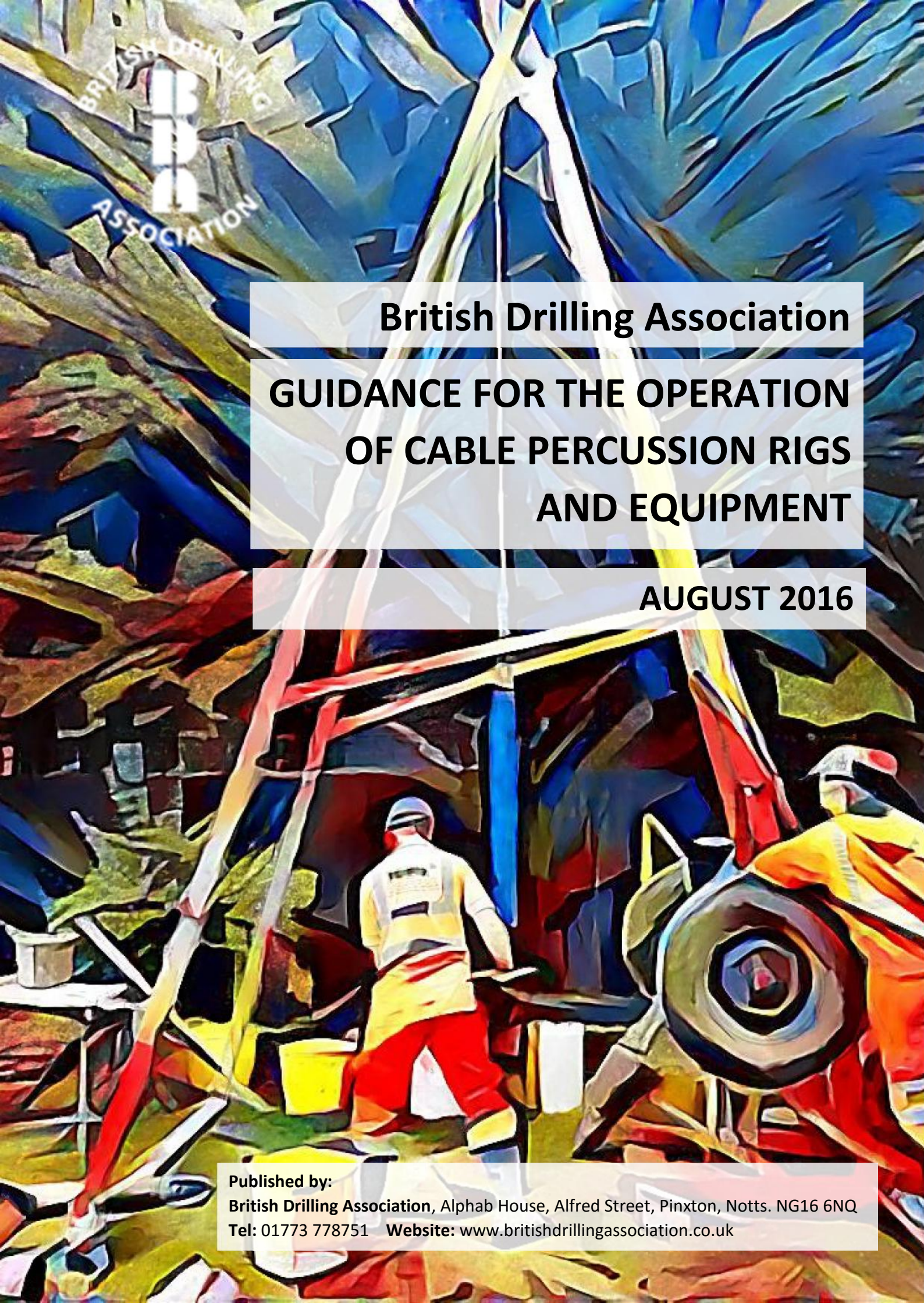

British Drilling Association

GUIDANCE FOR THE OPERATION OF CABLE PERCUSSION RIGS AND EQUIPMENT

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NOTE:
This publication has been written to include advice from the Health and Safety Executive (HSE).

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The recognition of the various and individual responsibilities of "DUTY OF CARE" are fundamental to the application of these Guidance Notes and the principle of "Identify the hazard, consider the effect of suitable control measures, assess whether the risk is now sufficiently low" should always be applied.

ACKNOWLEDGEMENTS

The British Drilling Association wishes to express its appreciation to all those individuals and organisations without whom many operational good practices would not have been identified and included. Those listed below have contributed to the discussions, supplied suggestions, images and been involved with the preparation of this document. These Guidance Notes are a consensus of the participants' views and do not necessarily represent the views of companies or organisations involved.

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UK SI Drillers Forum for Change*

*The UK Drillers Forum for Change is a group of experienced current and retired drillers who share knowledge, develop safer drilling practices and promote good practice.

Foreword

For many years the British Drilling Association (BDA) has provided various Guidance Documents to encourage 'Good practice' within its membership and the wider drilling industry. This new cable percussion document sets out to achieve the same goal, updating and improving upon the previous guidance published in 2006

The document provides operational, technical and health, safety and environmental guidance for the operation of cable percussion rigs and their associated tools and equipment. It covers the area of cable percussion drilling, sometimes referred to as shell and auger or cable tool boring or drilling, which is performed by rigs of A-frame **I** tripod design. These rigs are mobile plant and are commonly towed to and from site by means of a suitable vehicle. The rigs are primarily used for ground investigation but are also used for waterwell drilling and some piling operations.

Cable percussion drilling techniques are particularly well suited to the variability of UK geology and can often provide a flexible and economic method of formation of exploratory holes in a variety of soil types and weaker rocks. The use of multiple casings of different diameters can allow effective installation of seals against downward migration of contamination where required. The drilling plant is highly mobile and of significantly less weight than the rigs required for many other drilling methods.

For these reasons cable percussion drilling has performed a key role in UK geotechnical investigations since the post war construction booms of the 1960s and 70s and it remains one of the principal methods of borehole formation in the UK. The tripod type plant and equipment used has little changed over the subsequent decades, the most significant evolution being the steady increase in winch capacity of the rig, with the single-line pull increasing from 1 or 1½ tonnes up to 4 tonnes. Guarding, particularly around the winch drum and clutch and brake assemblies, has become the norm, Electric winches for the raising and lowering of the A frame which have been standard on all new rigs since 2008 are now being widely used and specified
The in-hole drilling and sampling equipment used is largely unchanged. The driven open tube U100 (previously U4) sampling equipment has been augmented with the UT100 equipment for appropriate ground conditions in an attempt to obtain undisturbed samples of Class 1 quality suitable for laboratory testing although this does not always occur.

In recent years there have also been growing concerns around health and safety issues with the cable percussion drilling technique. These include the use of unguarded drop tools, rig engine starting and erection/lowering, manual handling of the heavy equipment and longer term occupational health issues for the operatives relating to Work Related Upper Limb Disorders (WRULD). More recently still, issues have arisen regarding conformance to EN16228 which came into effect in the UK in October 2014 and which applies to drilling plant manufactured since that date.

The BDA considers that where the technique is operated with good, well maintained, plant and equipment and operated by competent experienced lead drillers using 'Good practice' as set out in this guidance, the method still has its place in the geotechnical industry.

The Association will regularly monitor the issues relating to health and safety, standards and specification to inform and educate its members and the wider drilling industry, it will also actively seek to promote improvement, especially to the plant and equipment in use and will, where necessary, update or revise this guidance document.

The BDA already operates an annual audit scheme to check compliance with Good practice and is providing training for drillers and apprentices.

Those specifying and procuring ground investigations / geotechnical work must also play their part in the process of selecting the most appropriate and safe methodology to achieve their required outcomes.

The selection of method for forming exploratory holes should primarily be based upon obtaining samples of the appropriate quality (BS EN ISO 22475 -1:2006) and/or in situ test information to meet

the defined objectives of the investigation. BS5930:2015 provides information on the effect of ground conditions, together with other considerations about the site including terrain, access etc., upon the selection of the appropriate drilling method,

There are a number of alternative drilling methods to cable percussion available including conventional and wireline rotary coring, rotary open hole drilling, sonic (resonance) drilling and for shallower holes, dynamic sampling. These may be used alone or in combination with other techniques.

Use of the Guidance Document.

For clarity, the document structure presents information in a logical sequence, with the first part covering applicable Health Safety & Environmental Legislation and Guidance and operator competency. This is followed by sections covering technical and operational matters, including sampling and testing, with later sections covering specific associated topics such as inspection and maintenance, transport and environmental issues. The advice and information is presented in a simple, concise manner for easy reference allowing it to be used as a practical reference manual by all levels of personnel in the drilling industry. Every effort has been made to identify all the relevant legislation relating to drilling and its associated activities with regard to safe working practices as far as possible.

Some of the tools and equipment used in cable percussion drilling are also used in other types of drilling operations e.g. drill rods, Standard Penetration Test (SPT) equipment, sampling equipment etc. Further reference to these items may be contained in other publications produced by the BDA.

This guidance should be read in conjunction with the BDA's 'Health & Safety Manual for Land Drilling – which is applicable to all types of drilling. The BDA reserves the right to clarify any apparent inconsistencies between the two documents.

It should be noted that the BDA may only give advice as to compliance with UK Legislation, National, European and International Standards. The ultimate responsibility for complete compliance lies with the individual parties concerned.

The adoption of these Guidance Notes by all who commission, or are active in cable percussion drilling should be encouraged in order to establish good practice, quality work and safe operations.

The British Drilling Association believes that the contents of these Guidance Notes will provide a positive contribution towards the improvement of safety standards in the drilling industry.

SECTION 1

INTRODUCTION TO CABLE PERCUSSION DRILLING

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1.0 Introduction

The drilling method generally known as Cable Percussion drilling or Shell and Auger or Cable Tool drilling is carried out using a mobile drilling rig. The rig typically consists of a tripod mast structure and diesel powered winch unit mounted on a wheeled base frame (see Cable Percussion Rig Illustrations Section 1.2). The winch unit has a manually operated clutch and brake system. The tripod mast is self-erecting through the use of a dedicated ancillary electric winch and when lowered to the transport position forms a trailer unit. Cable Percussion frames have also been mounted on crawler (tracked) base unit, lorry and low ground bearing vehicles for specific projects or operational requirements. There are also modular or 'cut-down' variations which may be used for restricted access and low headroom projects.

The terms 'Cable Percussion' and 'Cable Tool' are synonymous but for the purposes of these Guidance Notes the term Cable Percussion is used. The term Shell and Auger is derived from a time when the method used a short auger on rods to clean out the base of the borehole during drilling. Augers are no longer used with Cable Percussion rigs in the UK.

Cable Percussion methods utilise a basic technique which in certain ground conditions such as coarse grained materials (gravels) is an efficient and effective technique. The method is also extremely versatile which makes it an effective method for sampling and testing soft ground, overburden, superficial materials, glacial tills and Made Ground.

The method is used primarily within the ground investigation and water well drilling sectors but is also used in some foundation piling operations. Piling operations are outside the scope of these Guidance Notes.

These Guidance Notes are produced by the British Drilling Association (BDA) to improve the knowledge and understanding of everybody involved in projects using Cable Percussion drilling methods. It provides guidance on the safe use of Cable Percussion rigs and equipment and also provides guidance on the technical Standards and good practice for the drilling operation, sampling, testing and reporting.

1.1 Cable Percussion Method Overview

The methods used for Cable Percussion drilling enable the penetration and sampling of a variety of different strata from very soft alluvial deposits to very stiff clays and silts as well as granular materials. The method is unsuitable for the penetration or recovery of rock or significant thicknesses of hard materials such as concrete, brickwork or masonry.

The drilling equipment used in the process consists of a string of tools which can include a clay cutter, stubber, chisel, shell (bailer) or similar used in conjunction with one or two sinker bars. Appendix A includes an illustrated overview of the tools that may be used.

The tool string is attached to the drilling line (wire rope), which passes over a crown sheave at the top of the tripod mast structure and then to the winch drum on the base unit. The tool string is raised by the Lead Driller using the winch, and dropped by freefall action thus causing cutting, crushing and/or fragmentation of the formation and loosening of unconsolidated soils in the borehole being drilled. Chiselling may be used to penetrate boulders and other hard obstructions such as concrete and to prove the presence of harder formations at the base of a borehole. The fragmented cuttings and loose material are removed from the borehole by means of the shell (bailer), clay cutter or similar tools.

As the borehole advances it can be lined with temporary casing, typically steel, to stabilise the borehole walls and prevent collapse. The casing can be recovered once the borehole is completed. Various diameters of casings are available which can be telescoped/nested to reduce friction and extend the borehole depth through difficult strata to final depth.

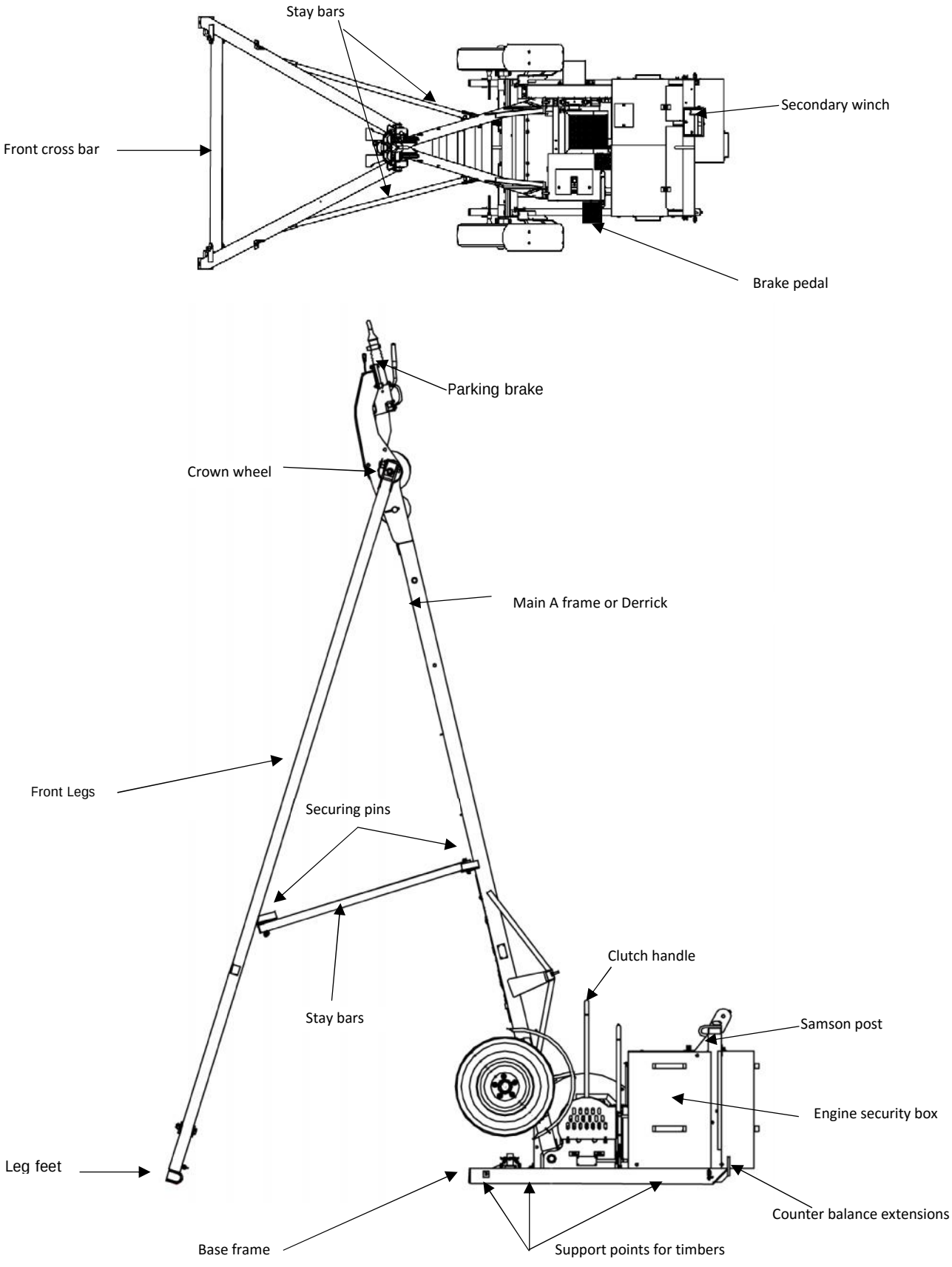
Undisturbed samples can be taken using specialist sampling equipment such as a U100 sampler, UT100 sampler, thin wall sampler, piston sampler or Shelby tube. Disturbed samples may also be recovered from the drilling tools. Section 7 provides more information on the sampling techniques and samplers.

In situ tests can be carried out in Cable Percussion boreholes. These may include Standard Penetration Tests (SPT), shear vanes and permeability tests. Section 7 provides more information on in-situ testing techniques and methods.

Upon completion, Cable Percussion boreholes can be installed with casing or backfilled with borehole arisings, grouted or have a monitoring installation installed. Section 8, Installations provides more information on installation types and methods and Section 10, Reinstatement provides more information on reinstating the boreholes.

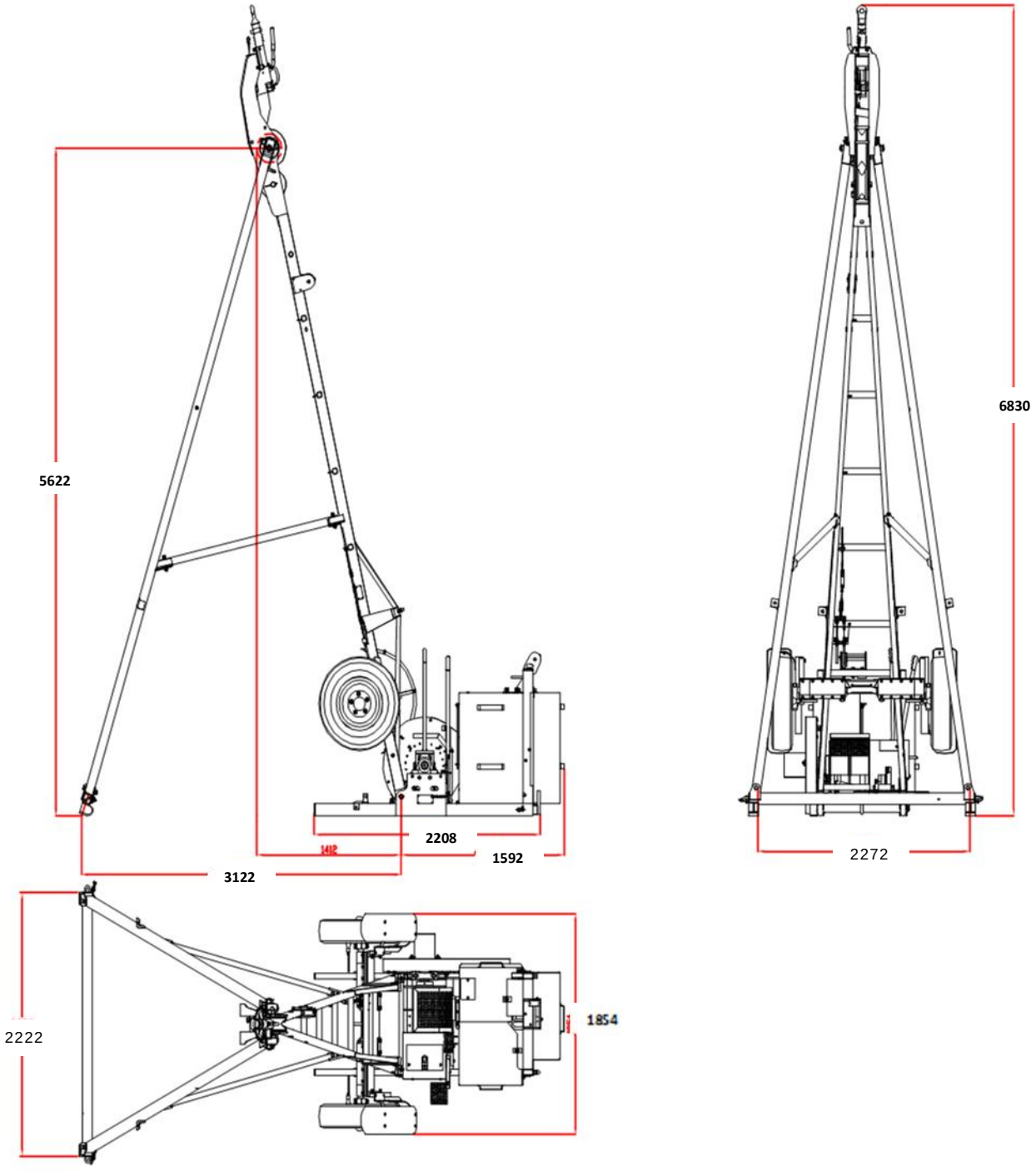
The drilling tools for Cable Percussion drilling are specifically designed to advance the borehole through variable ground conditions. They must be carefully selected before mobilisation to ensure that the drilling operation is carried out efficiently and safely. The drilling tools may be changed during the drilling operation as ground and groundwater conditions dictate. All drilling tools must be well maintained and kept in working order. On no account should defective equipment be used.

1.2 Standard Cable Percussion Drilling Rig - Major Components



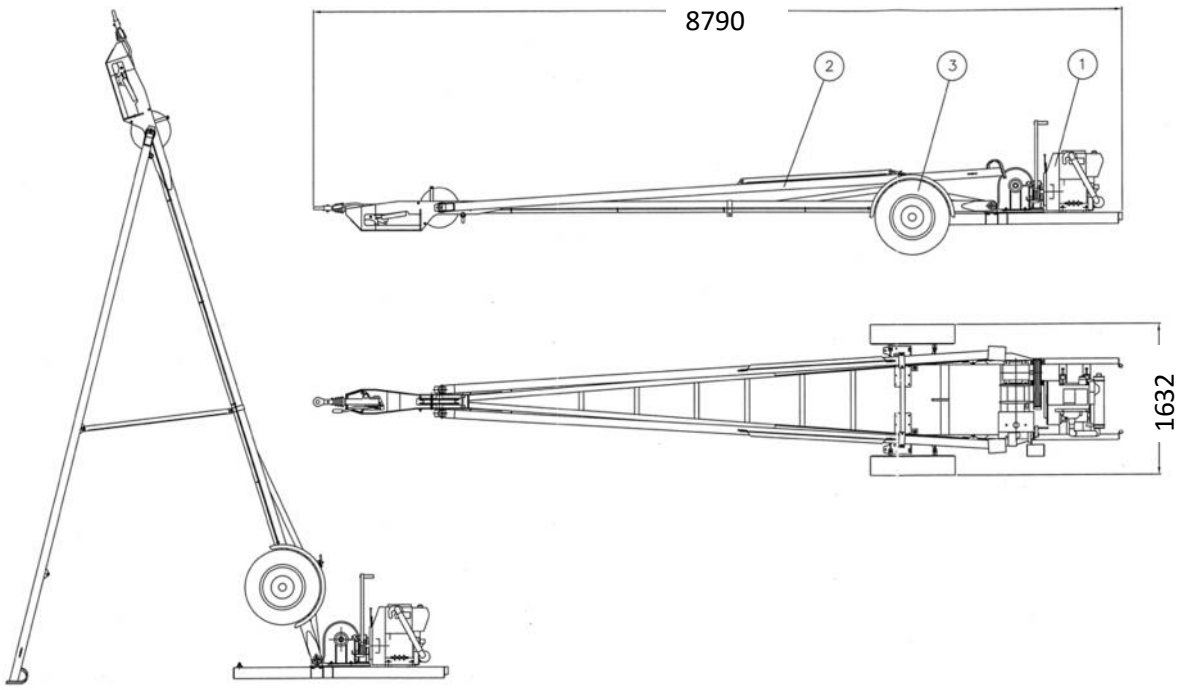
1.3 Standard Cable Percussion Rig - Dimensions

Dando 2000



Illustrations above are courtesy of Dando Drilling International

Pilcon Wayfarer 1500



Illustrations above are courtesy of Rig and Supply

1.4 Modular and Cut-Down Cable Percussion Rigs

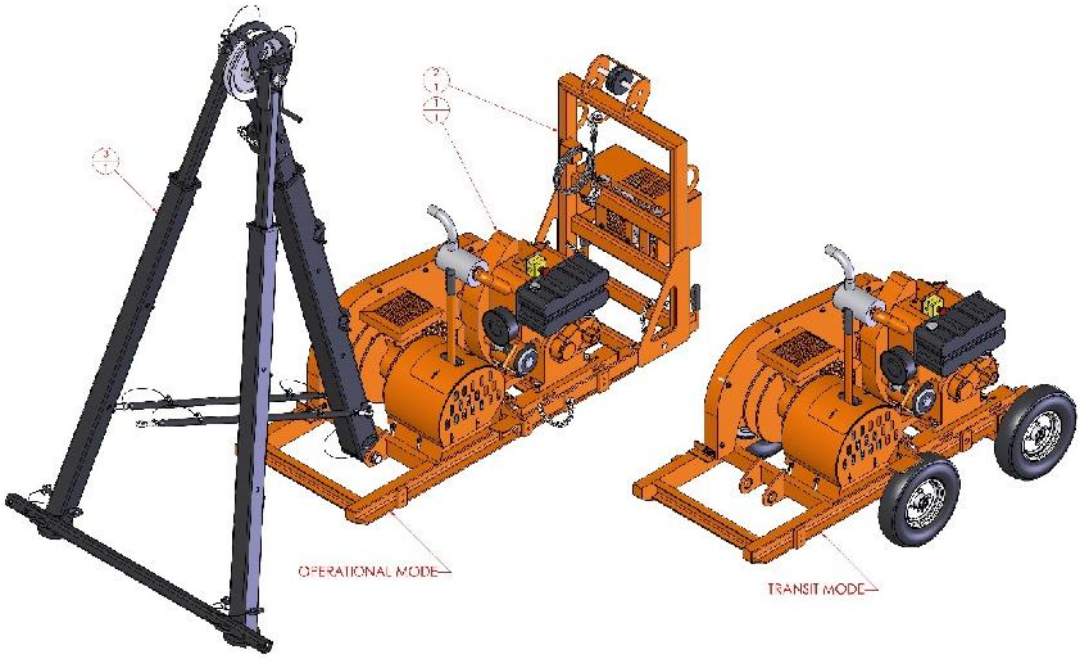
There are available on the market a variety of models of modular and cut-down Cable Percussion rigs. Many are modifications of standard rigs. They are almost entirely demountable allowing for these rigs to be used for restricted access and low headroom borehole positions. The principle of operation is exactly as the standard rig, but additional training is required for both the operation and assembly of the equipment. As with standard Cable Percussion rigs, modular and cut-down rigs must comply with the European Machinery Directive and harmonised Standards and carry CE certification.

Particular care must be taken in the planning of the operation which often requires increased manual handling, and careful consideration must be given to the provision of additional mechanical lifting aids and additional manpower to reduce this risk. The equipment must be dismantled into the smallest parts possible to manoeuvre to and from the borehole position. The current Dando D1500 LHR wheeled main frame skid weighs 612kgs and the mast assembly 249kgs. These are difficult to disassemble into smaller parts. Other models are able to be reduced in weight and size but often require additional means to manoeuvre around the site.

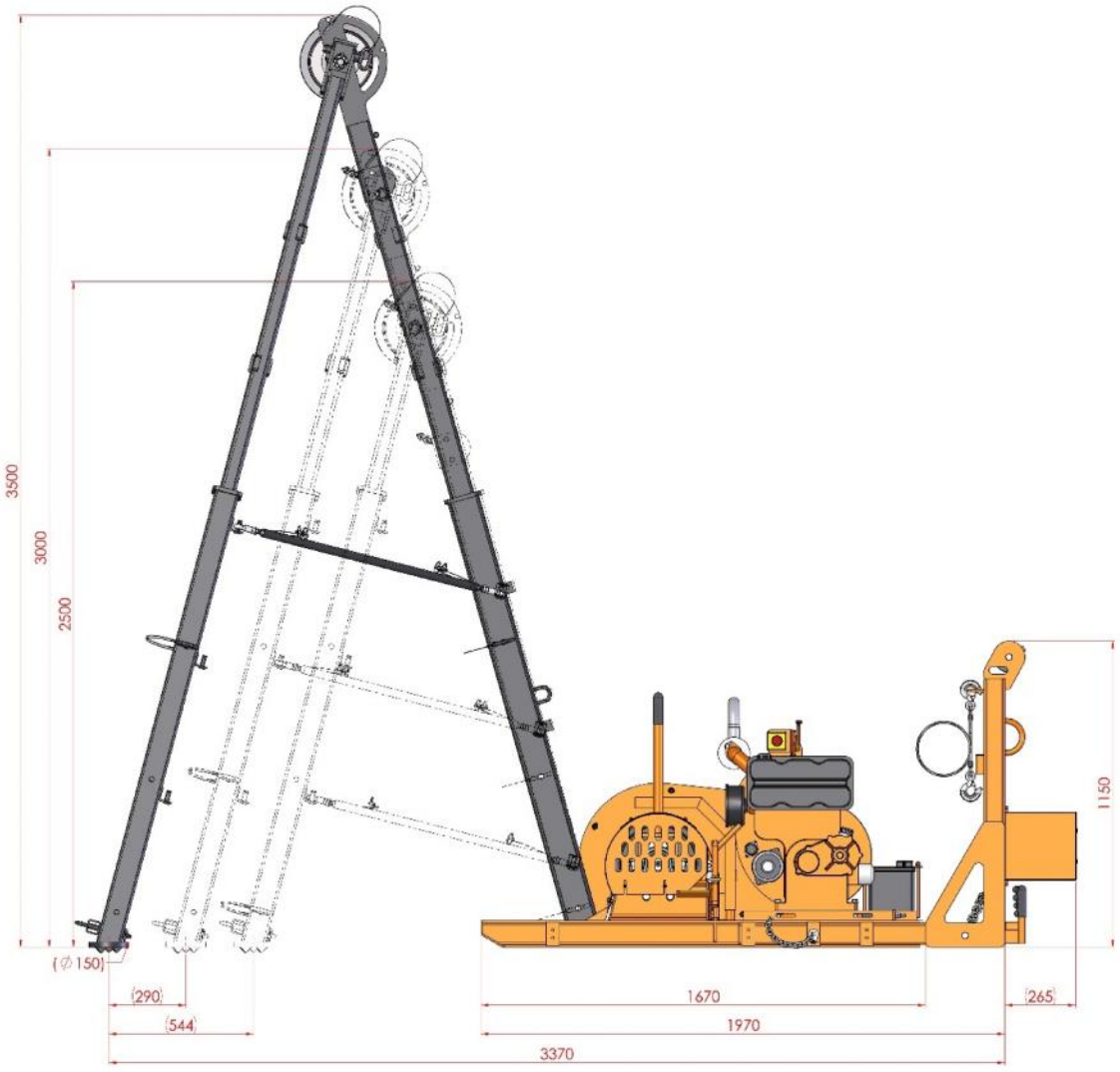
The equipment when used in low headroom areas is often used in confined spaces and adequate control measures must be planned and put in place such as adequate lighting and fume extraction. Electrically and hydraulic powered rigs are also available which reduces or removes the problem of diesel exhaust fumes which are hazardous to health.

In order for modular rigs to be used safely, wheels and other means of moving the equipment must be entirely removed prior to set up and stay bars or chains along with spreader bars must be in place. When used directly on concrete or other hard surfaces the rig should be secured in place by means of floor bolts or similar. Full guarding of all dangerous moving parts must be in place including gear box, clutch and winch.

The complex nature of the operation, logistics, use of smaller lengths of equipment and often reduced capacity of the rig to lift the weight of the drill string will severely reduce the efficiency and speed of the operation. Sufficient time should be allowed to plan and carry out cut-down Cable Percussion work so as not to create undue pressure on the drill crew and site staff. Modular or Cut-Down Cable Percussion boreholes should normally be restricted to a maximum borehole diameter of 200mm and it should be noted that the total depth achievable is very much strata dependant but rarely exceeds 20m.



Typical modular Cable Percussion rig



Typical dimensions of a modular Cable Percussion rig

1.5 Site Operatives

Cable Percussion rigs must be operated by a minimum of a two-man drill crew comprising:

- Lead Driller - the person who operates the rig controls and is responsible for the rig, drilling activity and drill site.
- Support Operative - the person who assists and supports the Lead Driller and drilling operation.

Health and safety within the drilling industry is always the prime consideration of the BDA. The principal aim is to ensure that all those involved in the drilling process, particularly the site operatives but also management, supervisors and employers, are aware of and practice safe working. The requirement to comply with National Legislation and Standards is the responsibility of every company and individual.

CSCS (Construction Skills Certification Scheme), National Vocational Qualifications (S/NVQs) and post qualification auditing is promoted by the BDA and full details are provided in Section 3.

The BDA is heavily involved in the development of these standards of competence for the site operatives. They have been designed to produce major benefits for both individuals and companies, thus raising the quality and understanding of industry standards and health and safety in the workplace.

SECTION 2

LEGISLATION, GUIDANCE AND STANDARDS

2.0 Health and Safety Legislation and Guidance

Health and Safety documentation comprises Statutory Instruments which are the Acts i.e.. Health and Safety at Work Act, Control of Pollution Act. These provide a high level description of the law. Acts are often underpinned by more specific regulations such as those covering Construction Design and Management (CDM), Work at Height, Manual Handling Operations, Lifting Operations and Lifting Equipment (LOLER) and Provision and Use of Work Equipment (PUWER).

To assist companies and individuals to comply with the law, the Health and Safety Executive (HSE) publishes many guidance documents in the form of leaflets, books and on its website. Following this guidance is not compulsory, unless specifically stated, but normally following the guidance will ensure you are complying with the law.

In addition, the HSE publishes Approved Codes of Practice (ACoPs) which provide preferred or recommended methods that can be used to comply with the regulations. An ACoP has a higher status as anyone following its guidance is generally seen as compliant. Not all Legislation has an accompanying ACoP.

The majority of HSE guidance documents are provided as free to download from the HSE website www.hse.gov.uk and can be searched by title or main topics. Particular industry guidance can be found on the BDA website www.britishdrillingassociation.co.uk and also on those of the Association of Geotechnical and Geoenvironmental Specialists (AGS) and Federation of Piling Specialists (FPS). In any dispute the wording of the Legislation will take precedence over the wording given in the guidance – whatever the source.

2.1 Health and Safety at Work Act

The basis of UK health and safety law is the Health and Safety at Work Act (HASWA). The Act sets out the general duties which employers have towards employees and members of the public, and also employees' duties to themselves and others. These duties are qualified in the Act by the principle of "so far as is reasonably practicable".

> Employer and Self Employed: Duty to ensure that their work is carried out in a manner, so far as is reasonably practicable, that his employee's other contractors and the public are not exposed to risks to their health and safety.
>
> Employees: To take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work.

In general, most prosecutions for health and safety breaches will be carried out under the relevant sections and clauses of the Health and Safety at Work Act rather than the ACoPs.

2.2 Construction Design and Management Regulations (CDM)

The majority of geotechnical site works come under the definition of "construction work" and therefore the CDM Regulations apply. Often they are part of a larger construction phase or project.

CDM establishes in law a number of duty holders - Client, Principal Designer, Designer, Principal Contractor and Contractor, who all have defined roles and responsibilities.
CDM indicates that the key elements to securing construction health and safety are:

- Managing the risks by applying the general principles of prevention.
- Appointing the right people at the right time.
- Making sure everyone has the information, instruction, training and supervision they need to carry out their jobs.

- Duty holders co-operate and communicate with each other and coordinate their work.
- Consulting workers and engaging with them to promote and develop effective measures.

A Client's Guide to the Construction Design and Management Regulations for the geotechnical industry has been produced by the Association of Geotechnical and Geoenvironmental Specialists (AGS) and is available from their website.

CDM requires the Principal Contractor to produce a Construction Phase Plan which must be communicated to all site workers.

Where the geotechnical contractor is the only contractor on site and when no other construction work is intended for some time, the geotechnical contractor could be made the Principal Contractor and possibly the Principal Designer. Contractors should not accept these roles without understanding what they are taking on.

2.3 Risk Management

The majority of the UK's health and safety law, including much of that from Europe, is based on the principle of active risk management. What the law requires here is what good management and common sense would lead employers to do anyway: that is, to look at what the risks are and where they are not low enough to adopt different or additional control measures until the risk is sufficiently low.

The Health and Safety at Work Act and associated Regulations impose upon a company the necessity to ensure that all personnel involved in the setting up, operation and maintenance of its drill rigs and ancillary equipment are fully conversant with all the operational procedures and safety measures required. It is necessary therefore that the company will: -

- Carry out continuing risk assessment
- Set up and maintain a training programme for all personnel

2.4 The Management of Health and Safety at Work

Impose a duty upon the employer to assess their entire operation from the point of view of health and safety. All companies are required to carry out risk assessment where significant risk exists. If the company has five employees or more the conclusions of the risk assessment should be recorded in writing. It should be noted that despite this it may be a contractual requirement that a risk assessment is provided by small companies.

Measures and procedures to reduce the possibility of an accident are the objectives of the company safety plan. The three prime objectives should be: -

- To create a "Safe Workplace"
- To encourage each employee to be a "Safe Person"
- To devise and use "Safe Systems of Work"

2.4.1 Safe Workplace

This is only made possible by a concerted effort by all concerned in the total drilling operation. The client, company and the employee all have an important role to play to remove or reduce as far as possible, any risk that may exist in the drilling operation. The company must ensure that the Cable Percussion drill rigs and ancillary equipment meet the required statutory regulations and must supply any personal protective equipment identified by the risk assessment. In addition, relevant safety training must be given to all personnel.

2.4.2 Safe Persons

A safe person is one who recognises a responsibility to protect themselves and others from risk. They are safety minded and in being so, if they identify a hazard, they will take immediate steps to address it. If it is beyond their capability to deal with the hazard, they must stop work and report it to their supervisor as requiring immediate attention.

2.4.3 Safe Systems of Work

The company must ensure that the Cable Percussion drill rig and its associated ancillary equipment, including the in-hole equipment selected for the specific drilling operation, will be suitable for the intended use taking into account site, operational and environmental conditions. Training in the safe operation of this type of rig and work system must be given to those involved. This programme must be updated, as necessary, to take into account changes in the development of safe working practices.

Adherence to the Manufacturer's Instructions and User Manual should form part of the Safe System of Work and these documents must be available on site.

The system of work must ensure a safe working environment whilst achieving the required task without damage to workers, others, equipment or the site.

2.5 Health and Safety Executive (HSE)

Health and safety law is enforced by inspectors from the Health and Safety Executive (HSE) or by inspectors from the local authority. Inspectors have the right to enter any workplace without giving notice. On a normal inspection visit an inspector would expect to look at the workplace, the work activities, the management of health and safety, and to check compliance with health and safety law. The inspector may offer guidance or advice. The inspector may also talk to employees and their representatives, take photographs and samples, serve enforcement notices and take action if there is a risk to health and safety, which needs to be dealt with immediately.

On finding a breach of health and safety law, the inspector will decide what action to take. Inspectors may take enforcement action in several ways to deal with a breach of the law. This can range from:

- Informal advice – where the breach is relatively minor, the HSE Inspector will give verbal or written advice

- Improvement Notice – served where the HSE Inspector believes that the person/duty holder has contravened one or more of the relevant statutory provisions in circumstances that make it likely that the contravention will continue or be repeated. An example would be to provide by a given date a missing Certificate of Thorough Examination for a rig that appeared to be in a reasonable condition.

- Prohibition Notice – served by the HSE Inspector on a person/duty holder if he or she is of the opinion that an activity carried on (or likely to be carried on) by or under the control of that person involves (or will involve) a risk of serious personal injury. An example would be a notice requiring a duty holder to provide, by a given date, a guard on a dangerous part of machinery.

Health and safety law gives the courts considerable scope for punishing offenders and deterring others. For example, a failure to comply with an improvement or prohibition notice may lead to prosecution which can be financially punitive, or lead to imprisonment, or both. Unlimited fines and in some cases imprisonment may be imposed by higher courts. HSE now operates a Fee for Intervention (FFI) cost recovery scheme. Under The Health and Safety (Fees) Regulations, those who break health and safety laws are liable for recovery of HSE's related costs, including inspection, investigation and taking enforcement action. If the Inspector has to write to you, or if they leave any written paperwork on site for you (other than leaflets for general guidance information) then this charge is likely to be triggered.

HSE also provides information, guidance and advice on health and safety related matters. This is available from the HSE website (www.hse.gov.uk) and in HSE's free and priced publications.

2.6 Standards

These Guidance Notes have been produced to not only provide information and good practice relating to health and safety but also operational guidance relating to the drilling operations, sampling, testing and reporting. These Guidance Notes provide reference to British (BS), European (CEN/EN) and International (ISO) Standards throughout. Whilst not exhaustive, the references indicate some of the more important standards that are or may be applicable in the UK and may provide assistance with specific areas of technical and safety requirements. For work in other countries, reference may need to be made to the appropriate National Legislation, Standards and Guidance.

Standards are subject to review and subsequent update. It is therefore essential that reference be made to the latest published edition including any amendment or revision which can be found on the BSi website.

The main Standards which are referenced in this guidance relate to the actual Cable Percussion rigs and equipment and technical Standards relating to Cable Percussion drilling, sampling and testing operations.

The EU Machinery Directive 2006/42/EC and associated harmonised Standards including BS EN 16228, Drilling and foundation equipment – Safety provide the requirements which equipment manufacturers must comply with to allow CE certification.

The EN 1997 (Eurocode 7) suite of documents provide details of the Standards required for geotechnical investigation projects and include BS EN ISO 22475-1 Geotechnical investigation and testing, Sampling methods and groundwater measurements. Technical principles for execution. The current most relevant British Standards are BS 5930 and BS 1377 which are reviewed as the suite of documents within Eurocode 7 are created and published. Any Standards or parts of Standards which conflict with the Eurocode documents are withdrawn and only parts which contain non-contradictory and complementary information (NCCI) have been retained.

SECTION 3

TRAINING AND COMPETENCY QUALIFICATIONS

3.0 Introduction

It is a requirement within the Construction Design and Management Regulations (CDM), that "No person shall arrange for a contractor to carry out construction work unless he is reasonably satisfied that the contractor has the competence to carry out that construction work". In other legislation, including the Health and Safety at Work Act, there is a requirement that individuals are trained and competent to carry out their work activity.

Drilling may entail employment of personnel inexperienced in this type of work, or being unfamiliar with the particular type of drill rig, the equipment or the drilling process involved and therefore appropriate training is essential. Due to the complexity of these factors, it is anticipated it would take 18 months to 2 years to become a competent Lead Driller of a cable percussive rig and even after this period the individual would require substantial ongoing support and training. Depending upon the individual's abilities and for those not completing an approved apprenticeship this period could be greatly extended.

Drilling competence can be verified simply by employment of a BDA Audited Lead Driller (Section 3.5) who will have provided proof to a competent industry experienced and registered BDA Auditor during the last 12 months.

3.1 Training

The most important factor regarding technical quality and safety on site is the complete education by means of practical and knowledge training of the drill crew in every aspect of the drilling operation and associated activities. Such training should include the basic operational requirements and safety precautions together with a thorough understanding of:

- arrangements on site – who is in control, security, welfare etc.;
- the dangers of and how to avoid underground services;
- manual handling;
- pre-use checks, inspection, thorough examination and what to look for;
- the correct use of the plant, equipment and tools;
- sampling methods;
- testing techniques;
- safe storage of tools and equipment;
- loading and unloading;
- transport;
- contaminated ground and chemicals which may be used in maintaining and operating the rig.

The prime concept of this training is to enable crew members to do their own job safely and efficiently and to work with other operatives and personnel involved in the work activity, ensuring that good safe teamwork and clear communication becomes instinctive. This not only results in steady and safe progress but assists in securing higher standards of data and samples being produced.

BS EN 22475: Part 2 provides the requirements of a qualified operator which in the case of Cable Percussion drilling would be the Lead Driller. In addition to the skills and knowledge listed above the individual is required to have a knowledge of soil and rock description, geological and hydrogeological conditions and the quality management system.

This section explains how the Cable Percussion contractor can, and should, demonstrate that operatives are suitably competent and trained in order to meet client requirements and the Standards.

3.2 S/NVQ Land Drilling Level 2

Vocational Qualifications (S/NVQ - Scottish/National Vocational Qualification) in Land Drilling Operations are competency based qualifications available to Lead Drillers and Support Operatives.

The Land Drilling NVQ is an OSAT (On Site Assessment and Training) competency qualification and is primarily an assessment of competency and not a training scheme. Training is only carried out where there is an identified deficiency in performance skills or knowledge.

The qualification is attained by an assessment process of performance, knowledge, skills and training against a set of National Occupational Standards (NOS) established by an industry led working party as the minimum level of competency. The assessment process takes place over a period of time by qualified S/NVQ Assessors, with occupational experience of Land Drilling using a variety of assessment methods including site observation, questioning, recorded discussion and witness testimony. The Assessor and NVQ candidate build up a portfolio of evidence against the assessment criteria and this is submitted for quality assurance. Awarding Bodies appointed by government qualification agencies make the awards after each qualification application has passed the quality assured process. The assessment and award process is independent of the BDA.

S/NVQ Lead Driller candidates elect to follow an assessment route (endorsement) particular to their speciality in Land Drilling. For Cable Percussion the route options are Cable Percussion, Ground Investigation or Cable Percussion, Well Drilling and the final award certificate should state this as an endorsement. Should the certificate not carry these words, the holder is not S/NVQ qualified on a Cable Percussion rig.

S/NVQ Support Operative candidates also have endorsements on their certificates showing competence and experience to support Cable Percussion operations.

In no circumstance should S/NVQ Support Operative qualified personnel use the rig controls other than while undergoing training and only then under direct supervision of an S/NVQ Lead Driller.

3.3 Drilling Apprenticeship

In recognition of the ageing workforce within the drilling industry and the lack of new entrants, the BDA and Construction Industry Training Board (CITB) introduced a two year Land Drilling Sector Apprenticeship Programme to attract newcomers, young persons and those who wish to transfer from other trades.

The outcome of the Land Drilling Apprenticeship is the award of an NVQ Land Drilling, Level 2, Lead Driller in whichever discipline the Lead Driller has specialised.

The Apprenticeship is founded on a training plan comprised of a training scheme delivered in-house by the Employer and monitored by the CITB/BDA, and approximately 23 external training days over the two year period by organisations approved by the BDA.

Further details can be obtained from the BDA web site

3.4 Construction Skills Certification Scheme (CSCS)

Formed in 1995, CSCS is a card certification scheme for individuals within the construction industry. Originally started for crafts people and operatives, CSCS has since expanded into supervisory and management occupations and now includes professionally or academically qualified routes as well.

Amongst its aims are:

- Maintain a record of workers in the construction industry with a recognised level of competence
- Raise standards of health, safety and environmental awareness
- Encourage construction employers to use skilled workers
- Achieve a qualified workforce

CSCS is controlled by a Management Board, which consists of representatives of employer organisations and trade unions. CITB-Construction Skills administers the Scheme under contract.

The Lead Driller and Support Operatives must register for their NVQ and then pass a computer based Health, Safety and Environmental test prior to obtaining their CSCS card, which carries the person's photograph and details of their work activity.

A range of CSCS cards are available and each is colour coded to denote levels within the scheme. Cable Percussion operatives should have a BLUE SKILLED WORKER CARD, which denotes that an NVQ Level 2 has been obtained. It should clearly state on the reverse the discipline in which the Lead Driller or Support Operative is competent.

Those registered and working towards an NVQ may apply for a Red Trainee card. Holders of the Red Trainee card have a maximum of 3 years to obtain an NVQ and qualify for a blue skilled worker card.

Further details of CSCS can be obtained on the internet (www.cscs.uk.com) or by contacting the British Drilling Association.

All Cable Percussion drill rig personnel should be encouraged to increase their technical knowledge and ability and to undertake specialist training. In particular, every assistance should be given to all drill rig crew members to obtain the appropriate S/NVQ.

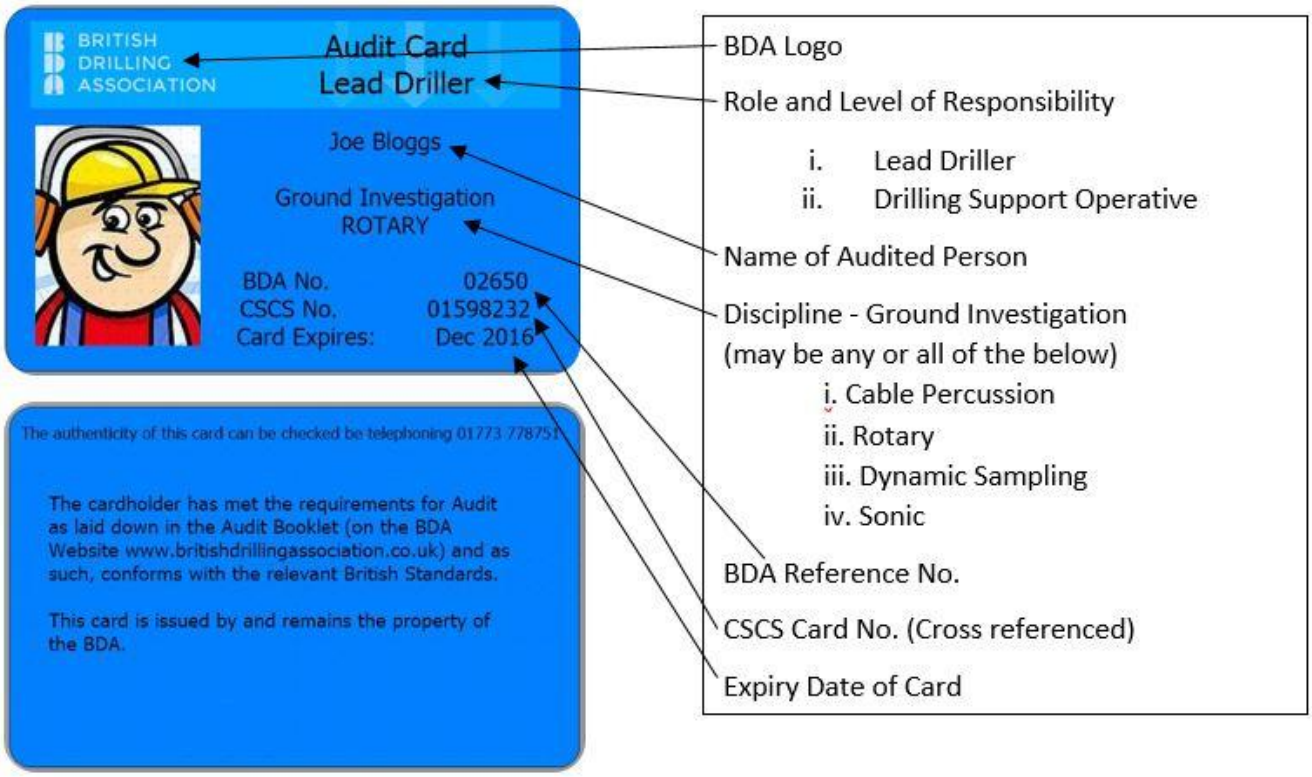
Employees are required to co-operate with their employers in any training or audit scheme used to maintain, increase or verify their competence and safe working practices.

3.5 BDA Audit

The Audit delivers a scheme specifically for the UK drilling industry that confirms Lead Drillers and Drilling Support Operatives have been assessed as competent to carry out their work productively and safely.

The Audit satisfies BS 22475 Parts 2 and 3 and Construction Design and Management Regulations (CDM) with regard to the need to prove the on-going annual competency of site workers.

An example of a Lead Driller card is shown overleaf.



Every member of the Cable Percussion drilling crew should hold their own valid BDA Audit Card.

A Blue Card holder may only carry out the drilling techniques specified on the Audit Card i.e. Rotary, Cable Percussive.

Whilst the Audit checks the individual's Construction Skills Certification Scheme (CSCS) Card, it is always recommended that these cards are also checked when the drilling crew come on site as the expiry dates are not always linked. Click here for CSCS card types

All drilling crew must hold an NVQ Level 2, Land Drilling - Lead Driller or Drilling Support Operative qualification to pass the Audit.

Click here to download an Audit guide and registration form.
Click here to download an example of the current Audit.

The benefits include recognition of competence for drilling operatives and for employers it satisfies tender specifications and provides third party evidence of their employees' capabilities and safety. Clients, under CDM, need to appoint a competent contractor. It is then for the contractor to ensure it uses a competent workforce. Clients should consider specifying the use of BDA Audited personnel as proof of competency for their projects.

The Audit looks in depth at the individual's current competence, their rig and equipment. Legislative requirements feature heavily. It is available for all members of a drill crew, whether Lead Driller or Drilling Support Operative and in all drilling disciplines.

Other Audit requirements include:

- Emergency First Aid at Work certificate.
- Adherence to both LOLER and PUWER regulations for the drilling rig and accessories, along with inspection of all drilling tools,
- Appropriate method statements and risk assessments

Audits are carried out by experienced assessors from the drilling industry and take half a day. Should non-conformances be identified, the individual and employer have to close these out within a set time period not exceeding 28 days from the audit date before an Audit card is issued. Failure to comply will result in withdrawal of the card and loss of Audited status.

The AUDIT is available to both members and non-members of the Association and its annual renewal provides ongoing proof of current competence.

On completion of a successful audit, the registered member is issued with an Audit Card, which is valid up until the time of the member's next due audit date. The BDA maintains a database of the status of any individual registered member. Enquiries can be made to the BDA office (Tel: 01773 778751) or the BDA website regarding a member.

The Audit Card is coloured BLUE for Lead Drillers and YELLOW for Support Operatives. It carries a member's photograph, name and expiry date, together with CSCS/BDA registration numbers.

The Lead Driller Audit Card also carries details of which drilling disciplines the member is audited against. For Cable Percussion operatives the card should carry the words "Ground Investigation – CABLE PERCUSSION".

The Support Operative Audit Card carries the words "Drilling Support Operative"

3.5.1 Key Audit Requirements

The table below presents the key requirements of a BDA Audit together with the reference documents which originate these requirements and the failure outcome. This is not an exhaustive list of the audit but provides a summary of the documentation or services required to be checked by the Auditors whilst on site.

BDA Audit Requirement	Reference	Failure Outcome
Rig must have a Certificate of Thorough Examination (12 monthly)	LOLER & AGS Guidance	non-conformance safety critical
Lifting accessories must have current Certificates of Thorough Examination certified (6 monthly)	LOLER	non-conformance safety critical
A current SPT energy ratio calibration certificate	BS EN ISO 22476 Part 3	non-conformance minor
A Cable Avoidance Tool (CAT) and Signal Generator (Genny) with proof of calibration within the last 12 months must be available on site	HASAWA, PAS 128 and HSG 47	non-conformance major
If operating a CAT and Genny, the Auditee must hold a relevant training certificate	HSG 47, PAS 128 and AGS Guidance	non-conformance major
Construction Phase Plan to be available on site		non-conformance minor
A service avoidance procedure including all service drawings	HSG47, PAS 128 and AGS Guidance	non-conformance major
Welfare facilities are available	HASAWA and CDM and AGS Guidance on site welfare	non-conformance major
Evidence of induction having been carried out	HASAWA and CDM	non-conformance minor
Relevant Risk Assessments and Method	HASAWA and CDM	non-conformance minor

Statements (RAMS) are available		
COSHH assessments	HASAWA COSHH Regulations and AGS Guidance	non-conformance minor
A procedure for any activity which involves working at height	Working at Height Regulations & AGS Guidance	non-conformance major
Task related PPE	as detailed in the RAMS HASAWA PPE Regulations & AGS Guidance	non-conformance minor
If tight fitting breathing apparatus being used evidence of face fitting and wearer is clean shaven	HASAWA	non-conformance minor
A spill kit	HASAWA & Control of Pollution Act	non-conformance minor
An appropriate in date fire extinguisher	HASAWA & Fire Safety Regulations	non-conformance minor
An appropriate in date first aid kit and eye wash	HASAWA & First Aid Regulations & AGS Guidance	non-conformance minor
Auditee must provide evidence of Continuing Professional Development (CPD) during the last 12 months	CDM	non-conformance minor
Well maintained equipment and rig, no bends or cracks in frame work	PUWER	non-conformance major
A daily rig check sheet completed for both the current day and previous day.	PUWER	non-conformance minor
Emergency stops for all rigs which are clearly labelled.	PUWER	non-conformance major
Correctly fitted U Bolts if used	LOLER & AGS Guidance	non-conformance minor
Correctly erected drilling rig with all stays, jacks and or locking pins in place	Manufacturer's guidance	non-conformance major
Secondary electric winch fitted and working or manufacturers approved alternative.	Manufacturer's guidance	non-conformance minor
Correct guarding is in place	PUWER, HASAWA	non-conformance safety critical
Adherence to all driving and towing legislation where applicable, including light board and lighting	DVSA	non-conformance minor

The Cable Percussion rig is defined by the HSE and BDA as lifting equipment and must have a current Certificate of Thorough Inspection. All equipment used for the purpose of lifting including all shackles, swivels, safety hooks, bailing hook etc. must also have a current Certificate of Thorough Inspection.

In addition to the key requirements above, all aspects of the drilling operation will be observed including; drilling, monitoring, sampling, testing, installing etc. as applicable to the project being carried out. All operations must be carried out in accordance with ALL current Standards but principally BS EN ISO 22475 Part 1 and BS 5930. The Auditor will use modern techniques to record the audit including video and photographs, where applicable. A copy of the audit can be forwarded directly to the auditee and the relevant management where applicable. Minor non-conformances will require the auditee to rectify the problem or provide supporting evidence (i.e. certification, documentation) within 28 days. Major non-conformances will require the auditee to rectify the problem immediately otherwise the auditee will stop the audit. Safety Critical non-conformances are deemed to be the highest level of

failure outcome and if identified the Auditor will immediately cease the audit, leave site and the BDA will contact the auditee's employer.

3.6 Hired Plant

Where plant is hired, the plant and any associated equipment should be selected to be suitable for its intended use with appropriate certification.

Operators must be suitably trained and qualified in the correct use and maintenance of the plant. This is normally an NVQ appropriate to the specific piece of plant being operated. In addition to the NVQ, the operator must hold a valid CPCS card which will identify the exact plant operator competency such as dumpers and excavators. It is illegal to operate plant without appropriate training.

Example of a plant competence (CPCS) card

The plant and its equipment should be correctly maintained, inspected and must be supplied in a safe working condition. Any faults found with the plant at any time should be immediately reported to the plant hire company. Plant and vehicles should be treated with respect with every effort made to keep them secure and free from any damage.

SECTION 4

SITE SAFETY REQUIREMENTS

4.0 General Site Safety

Every site must be:

- set up with safe access and egress;
- secure so that unauthorised persons are prevented from entry;
- made free from risks to the health of any person working there;
- provided with sufficient workspace for the workers and equipment;
- provided with adequate welfare facilities;
- kept clean and tidy;
- displaying suitable signs at its perimeter;
- and be fenced off, where necessary.

Where public access is possible to a site, workers have a duty to ensure that access is controlled or restricted. This is especially important when the site will be left unoccupied over night or for long periods. The type of measure required will depend on the likelihood that members of the public will be in the vicinity of the work and the severity of the injury they are likely to sustain.

Typical means of preventing uncontrolled access to the working area include the use of 'Heras' type fencing, either mesh or solid panel, 'Chapter 8' barriers or 'Netlon' flexible mesh fencing supported on road pins. If using the last option, due consideration must be given to the risk of encountering underground services and suitable precautions taken.

Example of site protection

4.1 Site Planning and Management

Planning and management of Cable Percussion drilling works must take into account the risks to all those affected and it must cover:

- The risks likely to arise during the works
- The control measures needed to protect those affected
  - Provide and maintain the right plant and equipment
  - Provide the necessary information, instruction and training and
  - Provide the right level of supervision

- The resources needed to organise and deliver the work including management, monitoring and coordination.

4.2 Site Inductions

Site inductions should be provided to every site worker and those who do not regularly work on the site but who visit on an occasional basis i.e. visitors. The inductions should be proportionate to the hazards/risks that will be encountered and should take account of the nature of the visit. Inductions provided to escorted visitors need not have the detail that unescorted visitors should have.

A key responsibility of the person carrying out the induction is to pass on information on task specific risks e.g. to ensure that Lead Drillers and Support Operatives have been advised on site specific hazards for their Cable Percussion activity such as anticipated contamination, buried services, adjacent work etc. which might affect them.

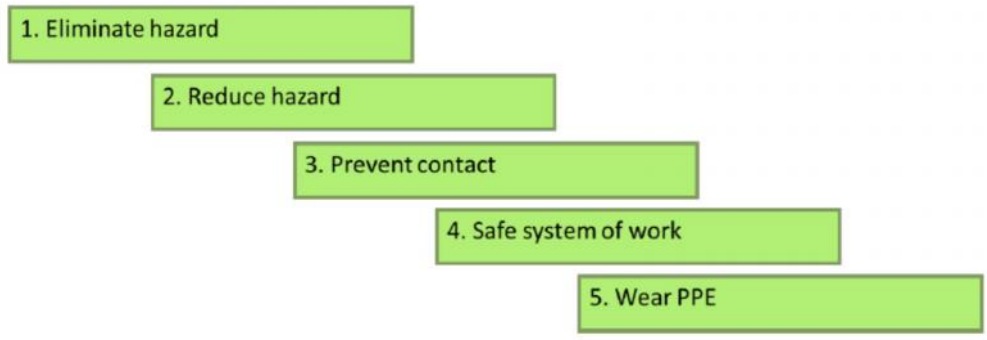
4.3 Risk Assessment

A risk assessment must be prepared for every operation of the work activities where there is likely to be a significant risk. Risk assessment is an essential element in the management of health and safety at work. It is needed to ensure compliance with the requirements of health and safety legislation and in particular with the Management of Health and Safety at Work Regulations. Risk Assessment involves a series of logical steps to examine the hazards arising from all the various aspects of the drilling operation so that appropriate safety measures are implemented. The ultimate objective is to achieve adequate safety according to the state of the art at the time. To be successful, risk assessment depends on logical judgmental decisions.

Any risk assessment carried out should recognise and take into consideration not only the operational activities but also possible hazards to occupational health (see Section 16) in the workplace and institute control measures to reduce the cause of these hazards to health as far as possible.

NO WORK CAN BE CARRIED OUT WITHOUT RECORDED EVIDENCE THAT A RISK ASSESSMENT HAS BEEN CARRIED OUT AND IS AVAILABLE.

The Management of Health and Safety at Work Regulations requires Employers with 5 or more Employees to record written risk assessments, however, most Clients and Principal Contractors will insist on written risk assessments. The risk assessment for significant hazards should identify control measures and these should adopt the principles of prevention and protection as follows: -



The risk assessment will provide input information to the method statement for the control of health and safety risk. This hierarchy requires consideration of opportunities to eliminate the hazard, or if not to control it by engineering methods, or if not possible by safe systems of work, including detailed training. Where exposure to substances is involved, the last resort is the use of Personal Protective Equipment (PPE).

In some cases a combination of these control measures may be selected. Note also that the selection of a particular control measure may introduce a fresh hazard that in itself needs controlling. The process is iterative and often needs to be worked through several times to achieve the ideal balance of measures to deal with the hazards involved and reduce the risk of incident to an acceptable level.

4.4 Method Statements

A method statement should be prepared for every job with significant risks and should be specific to that job. The method statement should clearly define every work activity.

NO WORK SHOULD COMMENCE UNLESS A SITE SPECIFIC METHOD STATEMENT HAS BEEN PREPARED.

The risks to health and safety for each activity should have control measures that have been identified in the risk assessment. The control measures should be included within the method statement as part of the method for carrying out the work.

The method statement should clearly identify the responsibilities of individuals.

The method statement should identify specific competence requirements for use of machinery and for carrying out the work.

Where the company has generic procedures documents these can be referred to in the method statement to save copying them out each time. This allows the method statement to be very specific to the site in question but still be linked to more detailed procedures and instructions. Each rig crew should carry a set of generic procedures documents.

THE CONTENTS OF THE METHOD STATEMENT SHOULD BE CLEARLY COMMUNICATED VERBALLY AND IN WRITING TO THOSE CARRYING OUT THE WORK.

4.5 Permissions and Notifications

In addition to the need to obtain the consent of the landowner and any tenant of the site on which the projected drilling is to take place, there are other bodies and authoritative parties who must be given written notification. The responsibility for carrying out notifications should be clearly agreed in writing between the client and the drilling contractor.

It is extremely important that each site is checked for the specific notifications that are required. The following list is included for guidance and may not be fully inclusive: -

- Planning Authorities
- Local Authorities
- Utility services: Gas, electricity including national grid and water
- Coal Authority
- British Pipeline Agency
- Telecommunications
- Airports Authority
- Highways England / Scotland / Wales
- Environment Agency / SEPA
- British Waterways
- Police
- British Geological Survey
- Health and Safety Executive
- Network Rail
- London Underground

It should be remembered that each drilling site will require separate and maybe different notifications. Some permissions such as use of traffic lights, pavement and road diversions or closures require significant planning as well as the appropriate permits to be in place.

4.6 Protection of the Public

The site should always be made as secure as possible against trespass by the public and especially by children at times when there is no one on site. Further information with regard to protection of the public may be obtained from HSE publication HSG151 Protecting the Public.

If the site has perimeter fencing, ensure that it is in good condition and any gates are secure. The fencing must be of a suitable type and adequate to prevent access to hazardous areas. If the site is not fenced ensure that all areas are as safe as possible and any excavations etc. are covered or fenced off, particularly when there are no authorised personnel on site.

Ensure that any public right of way affected by the drilling operation is kept safe and free from any hazard. It is very important to give special consideration to those members of the public with impaired vision or hearing, or with mobility problems. Public access should be clearly defined and signposted taking into account all disability groups and unaccompanied children.

Keys must not be left unattended in plant and all plant on site must be immobilised at the end of each shift and keys removed. If parked on sloping ground (even a slight incline) the wheels or parking brake must be locked so as to prevent movement by vandalism. If chocks are used these should be locked/chained in position.

All drilling tools and equipment should be safely and securely stored.

All statutory notices concerning the health and safety of the public must be clearly displayed in an area where the public may be present

Where company vehicles have to be parked on public roads owing to the position of the drilling site, they must be parked in such a manner that they do not present a hazard to the public or cause obstruction.

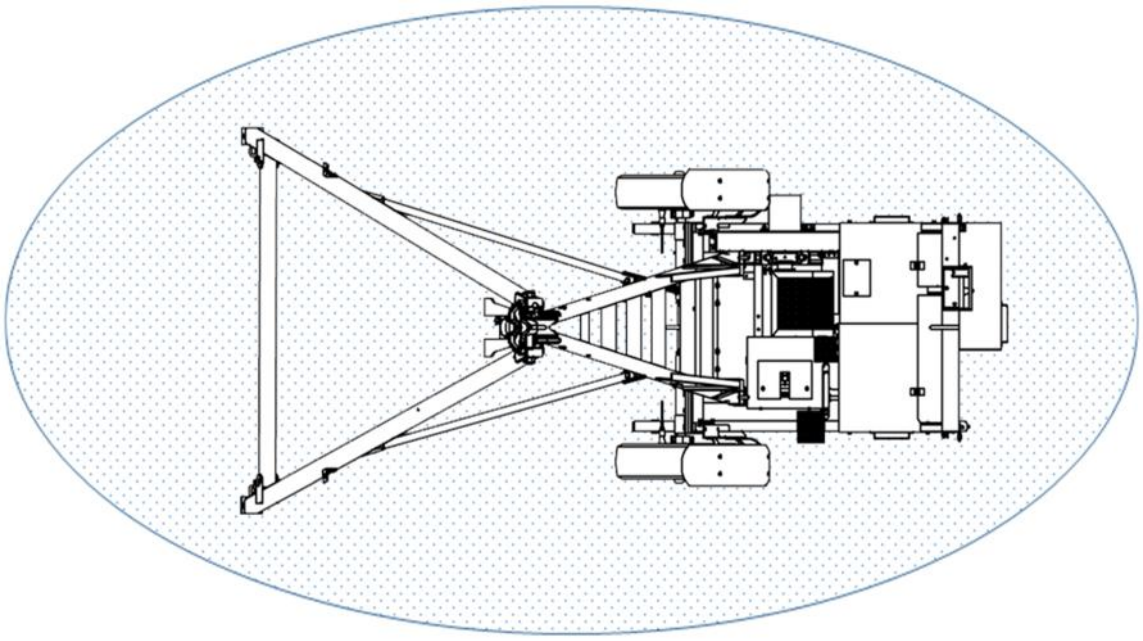
4.7 Visitors to Site

Visitors to the drilling site are exposed to the same hazards as company personnel and should be kept away from operational areas. Any visitors should hold a valid CSCS card. If necessary, operations should be suspended until visitors are moved to a safer position.

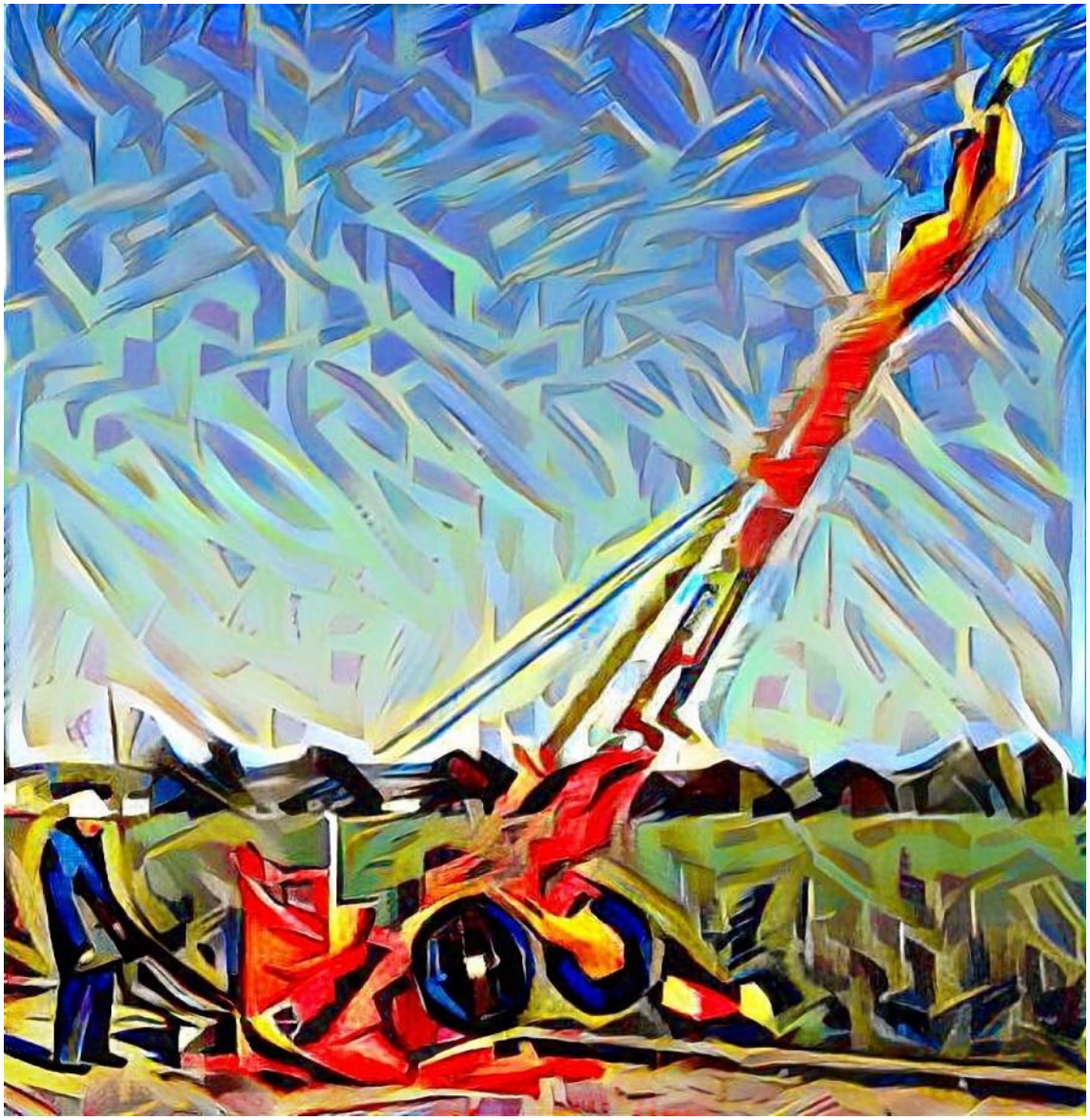
It should be remembered that visitors may not understand the hazards and may be tempted to stand in an unsafe place, or touch dangerous parts or materials. Lead Drillers and Support Operatives must anticipate this behaviour and prevent it.

All persons who visit the drilling site should receive appropriate induction, be accompanied, as appropriate, and be issued with the appropriate Personal Protective Equipment (PPE). Lead Drillers should ensure visitors either remain outside of the exclusion zone or stop work if a visitor enters the exclusion zone.

The Lead Driller should record any visitors to the site. On larger sites where a Visitors' Book is operated any visitor must sign in.



Suggested exclusion zone for visitors



SECTION 5

CABLE PERCUSSION RIG SET UP

5.0 Arrival on Site

In order to ensure a safe drilling site and reduce the level of risk there are a number of checks that should be made prior to the erection of a Cable Percussion drilling rig. Initial checks should be completed by the Supervisor prior to the rig's arrival to ensure that the Lead Driller has a suitable place to access the site and to store equipment. This should be identified in the Construction Phase Plan and include checking for possible access restrictions, unloading areas, buried services etc. Upon arrival the Lead Driller, once inducted and briefed upon the site specific hazards and site rules, should carry out a walk over of the access and egress routes and borehole locations. The Supervisor should not agree final borehole positions without consulting with the Lead Driller.

5.1 Positioning

In selecting a suitable position for the rig, it is essential that the position is level and that the surface is suitable for the erection of the Cable Percussion rig. Areas of soft, wet or uneven ground should be suitably covered and/or levelled to ensure a safe working area is provided prior to setting up the equipment. The use of track matting or bog mats may be required for some sites both to create safe access and egress routes as well a safe working area. The work site should also allow sufficient room to swing the rig's front legs around and set up all of the equipment in an area which is free from overhead and underground services.

The working area required for safe operation of a Cable Percussion rig will vary dependent upon a number of factors. These include the size of rig being used, the amount of tools and casing that need to be stored adjacent to the rig and the need to accommodate support plant such as trailers, bowsers etc. and towing vehicles.

As an indication an area of 10m x 5m should be considered as a sensible minimum.

The Cable Percussion rig must be set up on a firm and level working surface and be erected as per the BDA and Manufacturer's recommended procedure as outlined in Section 5.2. Members of the public and others should be kept at least 10 metres away from the rig whilst it is being erected or taken down.

If possible, position the engine downwind from the borehole so that the drill crew is not breathing in exhaust fumes. Exhaust systems should be designed to direct dangerous exhaust gases away and or above the Lead Driller's work position.

When positioning a rig on sloping ground, the engine base should wherever possible be positioned below the front legs. The rig should be levelled when working on slopes to ensure that the tooling drops centrally in the A frame.

In the past, it has been commonplace to manoeuvre rigs on to position using the main winch and attaching the wire rope to fixed objects. This practice is discouraged as it creates significant hazards to the drilling crew and site workers. Appropriate ancillary plant and independently assessed winch points should be used to eliminate this hazard.

5.2 Erection of a Cable Percussion Rig (recommended method using a secondary electric winch)

The Lead Driller is responsible for the safe erection of the Cable Percussion rig and should be fully aware of the manufacturer's instructions and hazards during erection. This guidance assumes that all Cable Percussion rigs being used in the UK are now fitted with a Samson Post which provides a fixed anchor point to erect and lower the mast of the rig (see illustrations in Section 1).

An additional wire rope 5m in length with a safe working load greater than 2 times the lifting capacity of the drilling rig shall be attached the crown wheel securing point prior to erection. This wire rope shall be secured via a locking shackle of sufficient strength to ensure safe use on the additional wire rope. It shall be secured to the A frame at the lower end via means of a shackle when not in use. Instructions on the use of this additional rope is explained in section 6.4. of this guidance.

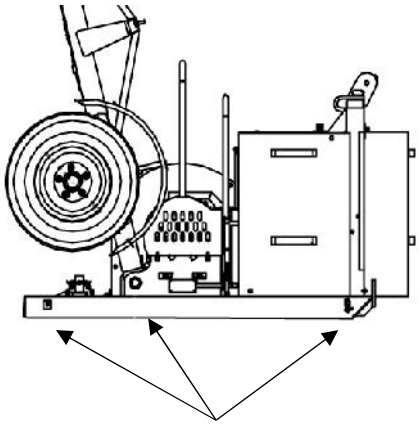
Shackle

Careful adherence to these simple steps will greatly reduce / eliminate the need to climb a Cable Percussion rig during operation.

1. Remove any loose items from the drill rig including, where fitted, the cross member and stay bars.
2. Apply the Cable Percussion rig hand brake (use chocks against wheels if necessary) and unhitch from the towing vehicle.
3. Remove the engine security box cover, if fitted, and place away from the working area.
4. Remove mudguards unless they are fitted with L or U shaped leg guidance brackets to prevent legs slipping.
5. Release leg stirrup locking bolts and chassis locking plates.

Where possible the rig base should be placed directly on to the ground with no timbers or packing. This allows the entire base to take the weight evenly. Where timbers are used for levelling, three timbers of good condition must be used placed in the following positions:

- one under the leg pivot positions and rig frame,
- one at the front and
- one at rear of the rig.



Support points if using timbers

Each timber should protrude no more than 100mm from either side of the rig and should be level and in line with each other, both side to side and back to front.

6. Attach the remote control unit to the electric winch and operate to remove any slack from the winch and wire.
7. Place an adequate counterbalance to the rear of the rig. This can be achieved by placing and securing casing or drilling tools on the fixed or sliding L shaped counterweight brackets (as shown below), until there is enough weight to ensure that the rear does not lift when winching the mast up.

Casing and tools being used as a counterbalance

UNDER NO CIRCUMSTANCES MUST A HUMAN COUNTERBALANCE BE USED.

8. Place the front legs on top of the road wheels, or on the mudguards, if they are fitted with L or U shaped leg guidance brackets, to prevent the legs slipping inwards.

The Lead Driller shall direct and ensure that all personnel stand well clear of the rig and outside the danger zone.

9. Check again to ensure that there are no loose items that could fall off the rig whilst it is being erected.
10. Confirm that there are no possible overhead obstructions or hazards (e.g. overhead cables).
11. Ensure that the area to the front, rear and sides of the rig are clear. Start the rig engine and standing well clear of the danger zone engage the electric winch to gently winch until the rig base rests on all the timbers. At this point stop winching.
12. Check that the timbers, if used, are still level and central.
13. Once the checks are complete, engage the electric winch again to winch the rig gently until the crown wheel is raised up to approximately 1 metre from the vertical and then stop winching. The Support Operative should now attach the safety strap to the Samson Post and the A frame eye bolt.


Safety strap attachment points

14. The legs should now be walked around to the front by the Support Operative. The Support Operative must not walk under the raised mast but walk behind and around the rig. The Lead Driller should remain at the controls of the electric winch until both legs have been walked around. The cross bar and side stays should now be attached with the correct approved fasteners. The side stays must be attached from the floor using a method which removes the need to climb the main A frame or derrick.

The front legs should be as close to the floor as possible at all times whilst the legs are moved around. Only correctly designed stay bars and cross bar, as supplied by the manufacturer of the rig, should be used, and these must be securely held in place at all times by securing pins or bolts.

Where the front legs have removable feet these must be fitted prior to timbers being placed under the legs and before the legs are lowered.

15. Remove the safety strap and lower the rig to the ground with the secondary electric winch.
16. Check that the rig is resting on all timbers and that tools are hanging centrally.
17. Allow for some slack in the secondary electric winch line before removing the remote control and storing in a dry place. The remote control must never be left plugged in.

The rig is now ready to operate as soon as pre-start checks have been carried out. Appendix E provides an example of a Pre-Start Check Sheet for Cable Percussion rigs suitable for Lead Drillers and Appendix G provides an example of a Pre-Start Inspection Sheet for Supervisors.

5.3 Lowering a Cable Percussion Rig (recommended method using a secondary electric winch)

1. Check the position of the timbers, ensuring that the front timber is right at the front of the engine chassis.
2. Place sufficient balance weight on the L shaped counterbalance weight brackets.

UNDER NO CIRCUMSTANCES MUST A HUMAN COUNTERBALANCE BE USED.

3. Ensure there is nothing underneath or to the side of where the rig will be lowered.
4. Insert the remote control of the electric winch. Gently apply tension to the wire rope and attached the safety strap. Now carefully from the floor remove the cross bar and side stays.
5. With the Lead Driller at the controls the legs should now be walked round by the Support Operative without walking under the raised mast, walking behind and around the rig, and rested on the road wheels, or on top of the mudguards fitted with L or U shaped guidance brackets.

The Lead Driller shall direct and ensure that all personnel stand well clear of the rig and outside the danger zone.

6. Remove the safety strap and gently lower the rig using the electric winch in a steady manner until the “A” frame meets the rig base.
7. Ensure that the hand brake is on, then position the rig legs in the stirrups.
8. Refit the stirrup and chassis locking bolts.
9. Remove the counterbalance weights from the rig.

The rig is now ready to move to the next location.

5.4 Erection of a Cable Percussion Rig (alternative method for a rig without a secondary electric winch)

There are still a number of older Cable Percussion rigs being used in the UK which have not been fitted with a secondary winch. The use of a secondary winch will ensure safer erection and lowering of the rigs by removing the Lead Driller from the danger area. As the use of rigs without secondary winches is not prohibited in the UK, this section provides guidance on good practice to erect these rigs safely. However, this method cannot be used by drill crews who wish to complete the BDA Audit.

1. Remove any loose items from the drill rig including, where fitted, the cross member and stay bars.
2. Apply the Cable Percussion rig hand brake (use chocks against wheels if necessary) and unhitch from the towing vehicle.
3. Remove the engine security box cover, if fitted, and place away from the working area.

4. Remove mudguards unless they are fitted with L or U shaped leg guidance brackets to prevent legs slipping.
5. Release leg stirrup locking bolts and chassis locking plates.
6. Run the winch cable over the crown wheel and back through the “A” frame via the pulley fitted to the second cross member of the A frame (Note this cross member must have been strengthened to allow for this method of set up). Then attach it to the Samson Post by means of a shackle. The wire rope should never be threaded above this level unless a safe system of work is in place allowing for threading / unthreading of the wire rope without the need to climb.

Under no circumstances should the wire be passed around the side of the A frame. This causes both wear to the wire rope and A frame. The rig can also become unstable during erection and lowering.

7. Place an adequate counterbalance to the rear of the rig, until there is enough weight to ensure that the rear does not lift when winching the mast up. This can be achieved by placing and securing casing or drilling tools on the fixed or sliding L shaped counterweight brackets.
8. Place the front legs on top of the road wheels, or on the mudguards, if they are fitted with L or U shaped leg guidance brackets, to prevent the legs slipping inwards.

The Lead Driller shall direct and ensure that all personnel stand well clear of the rig and outside the danger zone.

9. Check again to ensure that there are no loose items that could fall off the rig whilst it is being erected.
10. Confirm that there are no possible overhead obstructions or hazards (e.g. overhead cables).
11. Ensure that the area to the front, rear and sides of the rig are clear. Start the rig engine, set the engine throttle to give the correct winch speed.
12. Once the checks are complete, winch the rig gently ensuring that the Lead Drillers foot is over the brake pedal at all times, until the crown wheel is raised up approximately 1 metre from the vertical. Apply the winch brake and lock. The Support Operative should now attach the safety strap to the Samson post and the A frame eye bolt.
13. The legs should now be walked around to the front by the Support Operative. The Support Operative must not walk under the raised mast but walk behind and around the rig. The Lead Driller should remain at the controls until both legs have been walked around. The cross bar and side stays should now be attached with the correct approved fasteners. The side stays

must be attached from the floor using a method which removes the need to climb the main A frame or derrick.

The front legs should be as close to the floor as possible at all times whilst the legs are moved around. Only correctly designed stay bars and cross bar, as supplied by the manufacturer of the rig, should be used, and these must be securely held in place at all times by securing pins or bolts.

Where the front legs have removable feet these must be fitted prior to timbers being placed under the legs and before the legs are lowered.

14. Remove the safety strap and lower the rig to the ground with the winch.
15. Check that the timbers, if used, are still level and central.
16. Once safely erected remove the shackle from the Samson Post and re-thread the rope through the "A" frame.

If the Lead Driller has to assist the Support Operative with the side stays, the brake must be applied, locked and the engine switched off before he leaves the controls.

The rig is now ready to operate as soon as pre-start checks are carried out.

5.5 Lowering a Cable Percussion Rig (alternative method for a rig without a secondary electric winch)

1. Thread the wire rope through the "A" frame via the pulley then attach to the Samson Post with a shackle.
2. Place and secure sufficient balance weight on the L shaped counterbalance weight brackets.

UNDER NO CIRCUMSTANCES MUST A HUMAN COUNTERBALANCE BE USED.

3. Ensure there is nothing underneath where the rig will be lowered.
4. Gently apply tension to the wire rope to allow the removal of the cross bar and side stays. Apply and lock the brake and fit the safety strap, then switch off the engine. Remove cross bar and side stays and secure.
5. Ensure that the rope is correctly spooled on the winch drum and that individual strands haven't overlapped each other such that they could suddenly fall off each other allowing the rig mast to drop, thus jarring the rig and possibly causing the Lead Driller to lose control of the lowering operation. This could result in the mast falling in an uncontrolled manner.
6. With the Lead Driller at the controls the legs should now be walked around by the Support Operative without walking under the raised mast, walking behind and around the rig, and rested on the road wheels, or on top of the mudguards fitted with L or U shaped guidance brackets.
7. The Lead Driller shall direct and ensure that all personnel stand well clear of the rig and outside the danger zone.
8. With the safety strap removed gently lower the rig using both the clutch and brake in a slow, steady manner until the "A" frame meets the rig base.
9. Ensure that the hand brake is on, then position the rig legs in the stirrups.
10. Refit the stirrup and chassis locking bolts.
11. Remove the counterbalance weights from the rig.

The rig is now ready to move to the next location.

5.6 Set up Involving Scaffolding.

It is a common practice to set up a Cable Percussion rig on a scaffold platform where a suitable level working area is otherwise unavailable, such as cutting or embankment or slopes or over water.

The size and load-bearing capacity of such a platform will be dependent upon the type and capability of the rig being used and the nature of the work being carried out, including the amount and sizes of

casing required. This will define the required overall working load, together with local loading point locations and loads e.g. beneath rig legs.

The scaffold must be designed by a competent scaffolding designer and be built by qualified scaffolding engineers. The scaffold must be inspected by a trained and competent person prior to first use, at intervals of no more than 7 days thereafter, and following any circumstances which may affect the safety of the scaffolding e.g. high winds.

Whilst the design of any platform will be subject to individual assessments, which is outside the scope of the document, the following indicative example is provided.

Type of rig	D1500 (formerly D100)	D150	D2000	D2500	D3000	D4000	Pilcon Wayfarer 1500
Rig Weight	1500	1700	1700	1995	1850	2300	1875
Equipment Weight Approx.	1000	1000	1000	1000	1000	1000	1000
Max. Pull Down	1500	1500	2000	2500	3000	4000	1500
With addition of single block	3000	3000	4000	5000	6000	8000	3000
Min. Weight	5500	5700	6700	7995	8850	11130	5875

Allowing for some additional weight including operators. It is recommended that a scaffold for this type of Cable Percussion rig should be designed to be able to withstand a minimum weight outlined in the table above. It should be double boarded and cross boarded at 90 degrees and should be a minimum area of 10m long x 5m wide with kick boards (toe boards) and full hand rails fitted. Wherever possible the rig and equipment should be lifted onto the platform

Cable Percussion rig set up on a scaffold platform

5.7 Lifting a Cable Percussion Rig

Separate Lift Plans are not required for the everyday repeated lifts for the Cable Percussion drilling activity such as installing rods, casings and tools. These activities should be included in the method statements and site specific risk assessments of the operation.

The lifting of Cable Percussion rigs and equipment on to locations using cranes or other lifting equipment will require a Lift Plan and must be controlled by a Lift Supervisor. These lifts have to be planned and supervised by competent, trained and qualified personnel and it is unlikely that the Lead Driller or Support Operative will be suitably qualified. All lifting equipment and lifting accessories such as lifting chains/slings must be inspected in accordance with the Lifting Operations and Lifting Equipment (LOLER) Regulations. All equipment and accessories must be inspected to ensure that they are not damaged and are capable of lifting the weight of the rig (minimum of 3000kgs). The slings must also

be protected from abrasive and sharp edges. The slinging of the Cable Percussion rig and equipment should be carried out by a trained and qualified Slinger Signaller.

The Lift Plan should set out clearly the actions involved at each step of the operation and identify the responsibilities of those involved. The degree of planning and complexity of the plan will vary and should be proportionate to the foreseeable risks involved in the work. The Lift Plan will need to deal with ensuring that ground conditions are suitable for the crane or other lifting equipment that will be used to position the rig.

All loose materials and or equipment must be removed from the rig prior to lifting. When lifting different variants of the Cable Percussion rig, the lifting points may vary slightly due to the difference in weight and therefore centre of gravity. It is advised that a test lift is always carried out prior to lifting the rig more than 1 metre from the floor, to ensure that the rig is being lifted level and there is no risk of the chains/slings slipping.

Example of typical lifting points for a Cable Percussion rig.

Two of the chains hooks/slings choked around the box section between the engine and the wheels. Ensuring that the base and A frame remain together

One of the chains hooks/slings choked around the box section nearer the towing point.

These positions are with the rig in factory condition, with no extra parts and with the counter weights attached.

SECTION 6

DRILLING OPERATIONS

6.0 Drilling Operations

A crew of at least two competent members must be present on site at all times to safely carry out Cable Percussion drilling operations. One man operation or lone working of a Cable Percussion rig is not permitted.

The Lead Driller is responsible at all times for ensuring a safe drilling operation and borehole site. The Lead Driller must ensure that all safety guards and protective devices are fitted and in sound condition and comply with the requirements of PUWER.

All mechanical features of the rig such as sheave wheels, pins, clutches and brake mechanisms must be checked before drilling commences in accordance with the manufacturer's manual. The two side stays plus the cross bar must be securely attached before drilling commences.

There are areas of the drilling rig which carry significant risk to third party personnel and Section 4.7 provides a diagram showing the minimum exclusion zone. The Lead Driller is responsible for ensuring that personnel not involved with the drilling operation must be kept clear at all times and only competent persons should enter this area. On some sites this exclusion may extend to other site staff and logging engineers. The Lead Driller should risk assess every location and determine appropriate exclusion zones depending upon the site specific hazards. Many sites will require physical barriers/fencing to delineate the exclusion zone and prevent those not involved with the drilling operation from entering.

The Lead Driller must at all times be able to see, without any obstruction, the hands and feet of the Support Operative. Hands must be kept clear of the lip of the casing, driving bar holes and SPT (Standard Penetration Test) anvil surfaces. The Lead Driller must ensure that the Support Operative's hands and feet are clear when lowering tools or casing to the ground.

When drilling tools are not in use they must be laid securely on the ground or correctly positioned racks. If a tool is in regular use, e.g. SPT hammer, it may be rested against the rig if a stable position can be ensured.

Casing tubes and drill rod threaded joints must be fully screwed home and tightened before use, in order to minimise damage to the threads. They should also be lubricated with a biodegradable or vegetable based lubricating agent to ensure ease of use and sealing the joint.

Drilling tools must not be worked on or changed while suspended on the wire rope. Tools must not be left suspended in the mast overnight or when the rig is unattended.

When working with a modular/cut-down Cable Percussion rig, shortened or sectional tools should be used and particular care should be taken to ensure they are assembled safely.

The working area should be kept clean and clear underfoot, cuttings should be placed well to one side and/or placed in plastic bags or skips. Hand tools should be kept in a safe location when not in use. Do not leave them on the ground.

Personnel must never look down the borehole whilst tools are suspended overhead or if there is an upward flow of gases as these could be toxic or flammable. To view the borehole, any suspended equipment must be grounded.

6.1 Using a Cross-Cut / Stubber or Clay Cutter / Punch

The Clay Cutter, also called a Punch, and Stubber, also called a Cross-Cut, are used for the advancement of the borehole in cohesive materials and are both operated in the same manner. They are screwed to one or more Sinker Bars and attached to the wire rope of the rig via a suitable sized shackle appropriate to the rig's lifting capacity. A simple lift and drop operation is then carried out to force the tool into the material. This can be achieved by a number of small drops or bigger single drops, however, care should be taken on bigger drops to ensure that the hole is not advanced in excess of the required sampling / testing depth.

Water may be added to lubricate the cutting action however this should be kept to a minimum and only applied in small quantities. The adding of water must be recorded on the drilling log as this will affect the water (moisture) content of the material. If drilling in granular materials above the water table, water should be added. If drilling in granular materials or laminated clays below the water table, a positive head should be maintained in the borehole by the addition of water. The Clay Cutter or Stubber, whichever is being used at the time, is withdrawn to the top of the borehole and any material recovered within it extruded either by hand or by means of an extruding device. Samples obtained through this method are disturbed (Class 4 and above) and are normally taken as bulk samples, although environmental samples may also be taken.

Clay Cutter or Punch

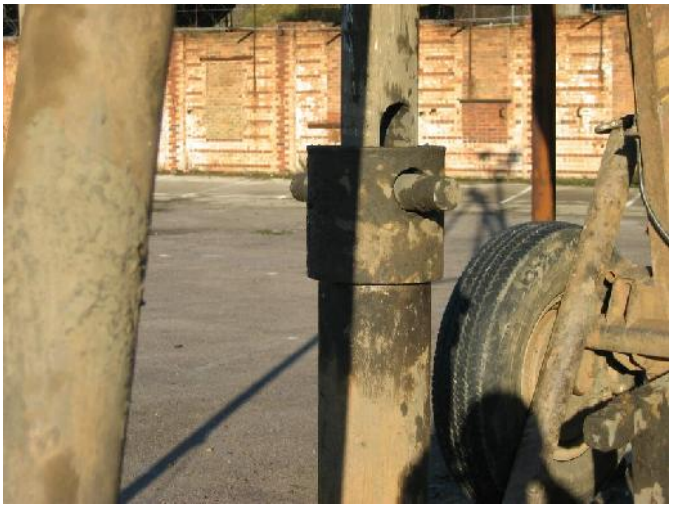
Stubber or Cross-Cut

6.2 Using a Shell / Bailer

The Shell, also called the Bailer, is used to progress boreholes in granular material but can also be used to progress difficult stratum encountered below the water table. The Shell is screwed to one or more Sinker Bars and is attached to the wire rope of the rig via a suitable sized shackle appropriate to the rig's lifting capacity. In order for this tool to operate correctly the entire tool must be submerged in water. The small percussive movement of the tool creates a vortex in the base of the tool loosening the granular material which is then washed into the tool via the one-way Clack-valve (Clack) near the base of the tool. Once material is washed into the tool the Clack closes, securing the loosened material inside. If the tool is not submerged completely the effectiveness of the vortex action is greatly reduced, resulting in less loosening of the material and slow progress. The water level should always be maintained above the natural groundwater level to maintain a positive balance of water within the hole. Dropping the bailer from higher in the hole has little or no effect on progress and could cause the gravel to be washed over the shell and cause the tool to become stuck (jammed) in the borehole.

Shell / Bailer

Periodically, once progress has been made, the bailer should be carefully withdrawn from the borehole and carefully emptied by laying the tool down and slowly lifting the base of the tool to allow the material to slide out of the top of the bailer. Where samples are required, the material should be collected in a container and the sample (Class 4 or above) taken from the container and not off the ground. Advancing of the casing (see Section 6.4) should be carried out only immediately after emptying the Shell and not during extraction.



Tapping bar in casing

Tipping of the Shell can be a hazardous exercise unless the correct procedure is used. The Shell should be lowered onto matting or timber placed alongside and to the front of the casing before being lowered to the floor. It should not be tipped with the bailer behind the casing and care should be taken at the tipping point to avoid the Shell falling uncontrollably. The Shell should be raised by means of a designated lifting hook and never by looping the rope around the lower end of the Shell.

Incorrect use of wire rope to tip the Shell

The lifting hook is regarded as a lifting accessory and should be designed as such and undergo a thorough examination every 6 months.

Lifting hook which should be used to tip the Shell

When empty, the Shell is carefully lifted to return to the borehole. The Shell will need to be guided to control pivoting when lifting it back into the borehole. It can be acceptable for the Support Operative to use their boot to support the Shell while it is carefully slid across the ground until it is firmly on the matting or timber. Extra care should be taken to avoid entrapment and/or crushing of hands and fingers between the Shell and casing when returning the bailer to the borehole. The Lead Driller should also ensure that the Support Operative keeps his feet from underneath the Shell while lifting.

Where penetration is made it is important not to over fill the tooling as this can result in the tooling becoming jammed in the casing. At the first sign of 'floating' and/or slow progress the Shell should be removed and emptied.

Using a Shell brings a considerable amount of water to the surface. The water from the drilling operation must be controlled at all times to ensure that no contaminants escape and pollution is caused. It should be noted that natural groundwater which contains fines such as clays, silts and sands are classified as contaminated and must not be allowed to enter any drain or water course. The use of sand bags and plastic sheeting is a common method to contain water but this can create an increased risk of slipping. The use of trackway or ground mats laid over the plastic sheeting significantly reduces this risk.

The Support Operative should ensure that the Clack is free moving before allowing the Lead Driller to lower the Shell back into the borehole. In loose materials the Support Operative should add water as the bailer is withdrawn to maintain a positive balance (head of water). If water is not being retained in the borehole the Shell should be placed on the base of the borehole before adding water.

A reduced size of shell compared to the casing may be necessary, to prevent excessive suction from developing during use of the shell. This can result in excessive material below the base of the hole, and laterally from the surrounding ground, being loosened and sucked into the shell.

6.3 Chiselling

Chiselling is an inefficient way to progress a borehole and is only used in difficult ground to progress the borehole and or to prove the existence of bedrock or an obstruction. It may also be used to break up small layers of hard strata/rock within a borehole.

Progress is best achieved by utilising frequent small drops of the chisel but the Lead Driller should take care to ensure that the chisel does not become stuck (jammed) into the base of the borehole. Water may be added, if the Lead Driller deems it necessary to achieve progress. Once the material has been broken it is often removed from the borehole using a Shell. A chisel shoe for a bailer is available and can be used where the removal of the material will improve progress. There are a number of different chisel shapes on the market but the star or cross is the most common.

Star or Cross Chisel

Chiselling is a generic term for advancing the Cable Percussion borehole through a hard stratum or obstruction which can be natural or man-made. Chiselling is loosely termed as a 'hard boring technique' (chisel/shell with additional weights etc.) in the UK Specification of Ground Investigation but then is more clearly defined as progress where Condition 1 and either 2 or 3 (below) are fulfilled:

> Condition 1: Boring with normal appropriate tools cannot proceed at a rate greater than 0.5m / hour excluding sampling and testing.
>
> Condition 2: 100mm diameter undisturbed sample tubes cannot be driven more than 300mm with 50 blows of the driving hammer.
>
> Condition 3: A Standard Penetration Test (SPT) shows a resistance in excess of 35 blows/75mm.

6.4 Casing the Borehole

Many boreholes will require temporary casing, typically steel, to be inserted to stabilise the borehole to prevent ingress be this from materials or water. Casing should be installed as and when necessary and this is often determined by the Lead Driller. Some deeper boreholes where the strata are well known may have pre-determined depths and sizes for casing. The depths of casings and borehole, hence casing diameters, are often pre-determined for water wells especially where the finishing diameter is defined by the required pump size and diameter of the well screen.

Casing comes in a range of sizes which typically range from nominally 150mm (6inch) to 450mm (18inch) i.d. with size changes every 50mm increments. These can be inserted either way up, depending on the shoe and casing head configuration but are more commonly pin-down (male thread down). They are normally supplied in 1.5m lengths, although casing of any length shorter than this are available. It is important that casings screw together well to ensure the borehole remains sealed.

Casing Shoes

A casing shoe is screwed to the base of the casing which can be of any of the designs as shown above and a casing head screwed to the top. The casing is then inserted into the borehole by one of the following means:

Surging

Lifting the entire casing up and allowing it to freefall down the borehole, lubricating, as necessary, with water or polymer. This method ensures that the casing can be inserted to the greatest depth without becoming stuck as the side wall friction is removed with each drop. This is the primary method of installing casing.

Tap and Jar

Utilising the slotted type sinker bar, the casing is tapped and jarred down the borehole. This again reduces the side wall friction and this method is often used to penetrate gravels. Lubricating casing during this process has no effect on progress.

Driving

This is normally the final option when inserting casing, as the casing is just continually knocked, tapped or driven into the material. In general, the harder it is to drive casing into the ground the harder it is to retrieve it. Casing should not be over-driven as this may result in plugging of the casing and poor or no penetration. This method sometimes leads to casing being unable to be advanced to the base of the borehole.

Positioning of the casing whilst using a Shell is critical to the progress as good preparation of the casing prior to drilling granular material is key. The casing should, wherever possible, be loose and free falling which should result in the casing following the Shell down the borehole. Turning the casing may also help to penetrate the material and keep the casing free.

Particular care must be taken prior to testing for the density of granular material as over drilling the borehole or overdriving of the casing can result in inaccurate results being obtained. The positive balance of the water must be maintained at all times during the test.

Lubrication of the casing can be by means of just clean water. Dirty or contaminated water should never be used. There are a number of drilling additive products on the market which can be used which are both very advantageous and environmentally friendly in assisting insertion of casing. These polymers can also assist in the drilling of difficult ground in similar ways to drilling additives used for rotary drilling.

Correctly designed driving bars must always be used and are available from suppliers of Cable Percussion equipment and are manufactured from EN 19T 45mm diameter steel. This is a high quality alloy steel which is renowned for its ductility and shock resistance and its resistance to wear properties. Vehicle half-shafts or similar types of materials shall never be used to surge or drive casing or any other

application as they have not been tested or manufactured for this use. They are extremely dangerous as they are very brittle and can shatter resulting in serious injury.

It is also good practice to have a designated lifting bar for withdrawing the casing.

Also available are lifting accessories in the form of Clevis and Pin. These are available from equipment suppliers and are used solely for lifting casing from the borehole. These accessories are subject the LOLER legislation and should be examined every 6 months.

Clevis and Pin

6.4.1 Nesting (Telescoping)

Where it is not possible to insert a single string of casing to the base of a particular stratum or borehole, nesting/telescoping or reducing may be required. This method uses a series of different diameters of casing which progressively reduce with depth to minimise side wall friction and maximise the total depth achievable. It must be stressed that if it is believed that nesting may be necessary it should be planned at the outset of the borehole so as to ensure the borehole is started at the correct diameter. When nesting or reducing is to be carried out the use of casing clamps as shown below is mandatory, these are available in all sizes of casing.

Casing clamps

After the completion of the borehole the casing is withdrawn from the borehole using suitable lifting accessories with each length of casing being unscrewed and stored for the next borehole. The casing head should never be left suspended above the drilling crew when removing the casing.

6.4.1.1 Use of a Pulley (Snatch) Block

If casing or tools become stuck in the borehole and cannot be released by jarring/back-hammering, one of two techniques may be employed.

The first option is to utilise a single extra pulley (snatch) block (single blocking) to increase the effective pull of the rig. The Lead Driller must ensure that the correct size of pulley block is used, so as to ensure that the lift does not exceed the Safe Working Load of the legs and sheave assembly, as stated in the manufacturer's manual. Use of this technique presumes that the additional wire rope required has previously been attached to the rig as described in Section 5. Attaching this rope with the rig already erected would involve avoidable working at height which must be avoided.

If use of a single block is required, the extension rope should be unshackled at its lower end and brought around the wheel on the A-Frame into the work area, checking that it is free from entanglement or obstruction. The free end of the extension rope is then secured to the free end of the main winch

rope by means of a shackle and the pulley block then attached to the loop so created, ensuring that the joint of the ropes in on the winch side of the pulley block.

The pulley block is then attached to the casing or tool using an appropriate shackle, either directly or by threading a knocking bar through the casing head with the pulley block located within the inside of the casing head.

The rig can then be operated with an additional pull of rope, thereby increasing the pulling capacity of the rig.

6.4.1.2 Use of Casing Jacks

Should casing still be unable to be removed using these method, then a suitable jacking system should be used to remove it. Proprietary casing jacks are available. Extreme care should be taken when using jacks as they impart huge loads on the casings.

Hydraulic jacks and power packs to be used for jacking shall have all relevant in-date certification prior to use.

Use of jacks requires that the ground in the immediate proximity of the casing is level and provides a suitable stable base against which the jacks can react.

Any soft ground or arisings shall be removed and hard-core or gravel placed instead.

A suitable bearing plate or arrangement of timber sleepers shall be placed over/adjacent to the casing and an appropriately sized casing clamp securely bolted to the casing to be extracted. If necessary, an additional short length of casing should be added to the 'stuck' casing string to provide sufficient clearance for the jacks to operate.

Two jacks of suitable capacity (typically 60-100 tonnes) are then placed and firmly located on the reaction bed and beneath the protruding legs of the casing clamps.

To allow safe operation, the hydraulic power pack should be positioned away from the immediate vicinity of the hole and be attached to the jacks with the appropriate hydraulic hose.

The jacks may then be operated by the Lead Driller and the casing eased gently out of the ground until it is free enough to be pulled by the rig. The jacks, sleepers and plate (if used) will then be removed and any remaining casing extracted using the rig in the normal way.

6.5 Groundwater Measurement

When Cable Percussion drilling, it is essential that the most information possible is obtained about the behaviour of groundwater encountered in the borehole, or alternatively that none was encountered. Provision of this information is absolutely vital to those who are using the results of the ground investigation for design.

It follows that the Lead Driller must have available a working water level reading instrument (dipmeter) of sufficient length for the maximum borehole depth.

Groundwater measurements must be taken and recorded at the start and end of each shift and any other significant breaks in work. Measurements must include the time of reading, depth of the borehole and casing, in addition to the level of the water below ground, or recording 'dry' if none is present.

If water is encountered during drilling, work should immediately stop and the point of entry be recorded, together with the depth of any casing used.

The water level should then be measured and recorded every 5 minutes for a total period of 20 minutes. If the level is still rising after this time, this shall be noted. After 20 minutes, boring operations may resume. Casing should be used to attempt to seal off each water strike and the level at which this was achieved must be recorded or, alternatively, it should be noted as 'not sealed'.

6.6 Artesian Water

When Cable Percussion drilling it is possible that the action of puncturing an impermeable strata may release a 'trapped' head of ground water from more permeable strata beneath which may rise up the borehole casing and flow out at ground level. This is known as "Artesian Water".

If this situation occurs, it is important to attempt to rapidly stem the outflow. The simplest method by which this can be achieved is to add casing to increase the 'stick-up' above ground level until the water level stabilises inside the casing. If this is impracticable due to the height of 'stick-up', an alternative is to fit a closely sealed cap to the top of the casing which incorporates a pressure gauge to enable measurement of the pressure head to be made.

If artesian water is encountered during drilling this should be immediately reported to the supervising engineer and appropriate measures agreed regarding borehole continuation, backfilling and the possible installation of a ground water monitoring installation.

6.7 Inspection, Testing and Maintenance

Cable Percussion rigs should be inspected by the Lead Driller at the start of each shift and this should be recorded on a minimum weekly basis. All mechanical features of the rig such as sheave wheels, pins, clutches and brake mechanisms must be checked before drilling commences in accordance with the Manufacturer's Manual.

Brake, clutch, winch and engine emergency stop functional operation should be tested at the start of each shift and must be recorded.

Regular maintenance, including greasing, oil checks, tyre pressure, rope dressing, bolt tightness etc. should be carried out in accordance with the manufacturer's instructions.

If any repair has been carried out to the mast legs or braces, a new inspection by a competent person is required.

In addition, each Cable Percussion rig must be serviced annually in accordance with PUWER and thoroughly examined, as required by LOLER, and a Certificate of Thorough Examination issued by a competent person at least every 12 months. This interval should be reduced where the rig is being used in arduous conditions

Cable Percussion rigs experience high stress during normal use. Some parts wear faster than others – especially the rope. An important part of the daily and other inspections is to ensure that wear and deterioration is monitored. This allows spare parts to be immediately available and repairs/replacements to be carried out in good time when the component has reached its end of safe working life. Using this process correctly ensures that there is minimal down time and that a reasonable working life is obtained from components known to have limited life. The alternative of working the equipment until the most vulnerable component breaks is unacceptable and exposes the drill crew to risk of injury, and the company to unwarranted contract delays and necessary costs.

All inspections, tests and maintenance carried out must be recorded. The scope of the inspection regime is to identify defects or damage affecting safety.

- Pre-use checks. These should be carried out each time plant or equipment is used. These checks are essential and may be best done by the person who will use the plant/equipment. The person doing the checks must be competent to do them. Pre-use checks should be visual and where appropriate tactile. The whole piece of plant/equipment should be subject to checking and should be carried out in good light.

- Interim inspections. These are in-depth inspections and may be appropriate in addition to pre-use checks and detailed inspections. Interim inspections are those which are required to be carried out between detailed inspections, because a risk has been identified that could result in significant deterioration affecting the safety of the plant/equipment before the next date of the detailed inspection. Whether interim inspection needs to be carried out will depend on use, as will the frequency of any interim inspections necessary. Examples of situations where interim inspections may be appropriate include risks from transient arduous working environments, extreme weather conditions, contact with chemicals; acid or alkaline environments.

- Detailed inspections. These are more formal in-depth inspections, which are carried out periodically at minimum intervals specified in the inspection regime. A competent person should draw up the inspection regime. Detailed inspections should be recorded. It is recommended that there is a detailed inspection at least annually for plant and six monthly for equipment. For frequently used equipment it is suggested that this interval is reduced to every three months, particularly when used in arduous environments such as Cable Percussion drilling.

SECTION 7

SAMPLING AND TESTING

7.0 Specifying Sampling and Testing

Many sets of drilling instructions state that standard sampling and testing should be undertaken. BS EN 22475: Part 1 provides some guidance but is not very prescriptive and requires the specifier to know additional information such as foundation types and depths. The 'Yellow Book' UK Specification for Ground Investigation and BS 5930 provide clearer guidance and this is summarised below.

Standard sampling and testing requires a separate disturbed sample of every stratum, no matter how many strata are within the borehole. Samples should be representative of each strata and therefore should never be mixed.

In fine grained materials undisturbed samples (U100/UT100 depending upon soil conditions see Section 7.3) should be carried out at 1m intervals to 5m depth and at 1.5m thereafter. Small disturbed samples should be taken from the U100/UT100 cutting shoes and also at each change in strata and retained in an air tight container. In coarse grained materials SPTs should be taken every 1m to 5m depth and 1.5m thereafter. Small disturbed samples should be taken from the split spoon and at each change in strata and retained in an air tight container. Where a cone SPT (C) has been used a bulk disturbed sample should be taken over the range tested.

Where an inspection pit is required, standard sampling or testing should start from the base of the pit. Environmental or disturbed samples may be required within the inspection pit.

The actual (as built) depth of samples and tests should be recorded after careful measurement and not simply reported as the specified depths. Boreholes which show every sample and test at the exact depth specified generally do not show accurate measurement.

Where strengths are required from fine materials, alternate sampling and testing (U100/UT100 and SPTs) can be specified at the spacing indicated above. Alternating starting with a sample or a test between different boreholes can also provide good coverage of the stratum.

Where detailed stratum information is required such as for slope stability investigations continuous undisturbed sampling may be specified.

All samples should be labelled as indicated in Section 7.4.

7.1 Disturbed Samples

Small disturbed samples are typically retained in air-tight containers such as plastic tubs or glass jars whereas larger disturbed samples are put into plastic sample bags. The size of samples should be taken based upon minimum requirements for the likely laboratory testing to be carried out and large enough for them to be representative of the material mass. Small disturbed samples should weigh not less than 1kg, bulk disturbed samples not less than 10Kg and up to 25kg and large bulk disturbed samples not less than 30kg.

Where samples are required for testing, or where it is desirable to keep them in good condition over long periods, they should be treated as follows. Immediately after being taken from a borehole or excavation, the sample should be placed in a non-corrodible and durable container of at least 1 litre capacity, which the sample should fill with the minimum of air space. The container should have an airtight cover or seal so that the natural moisture content of the sample can be maintained until tested in the laboratory.

7.2 Groundwater Samples

Where groundwater is encountered during drilling it should be sampled into an appropriate sealable container of not less than 1 litre.

Where more than one groundwater strike is observed each one should be sampled separately. Samples should be taken using a shell/bailer or dedicated sampling tool.

Additional water samples may be specified at the start and end of shifts, for example where drilling is taking place adjacent to tidal water.

7.3 Undisturbed Samples

7.3.1 U100 Sampler

The U100 (U4) sampler is a rugged and easy to use sampling system which is widely used in the geotechnical industry. The U100 open-drive sampler has a 104mm inside diameter and the standard cutting shoe has an area ratio of 27%. The standard tube is 457mm long and is made from either steel or aluminium. A U100 sampler is defined as a Thick Walled Open Tube Sampler and at best will produce a Class 2 sample as described in BS EN 22475: Part 1.

The U100 sampler drive head should incorporate vents and a ball valve assembly to allow air or water to leave the top of the tube as soil enters at its base. The ball valve is also intended to improve the sample retention by preventing air or water re-entering the top of the tube if the sample starts to slide out. Because of the conditions under which the vents and ball valve are expected to work, it is important to ensure that the sampler head is cleaned before each sampling operation.

U100 sampler

The sampler can be used with a liner system, normally plastic, however, the inclusion of a plastic liner, typically about 3mm thick means that the barrel and cutting shoe thickness is increased giving the sampler an area ratio of 45%. This increase in area ratio has a very significant effect on reducing sample quality and may render the sample quality Class 3. The standard sample tubes are threaded both ends and are attached to the drive head and cutting shoe before sampling. Cutting shoes should be undamaged with sharp cutting edge prior to the sample being taken.

The hole should be clear of any debris and the depth of hole, water level and casing depth monitored and recorded prior to starting the test. The sampler head should screw to a sliding hammer and a single sinker bar added to the drill string which is then attached to the wire rope by means of a shackle, which should be tightened with a spanner. When sampling in stiff overconsolidated clays, two sinker bars should normally be used to ensure a higher quality of sample is obtained. The assembly should then be lowered gently to the base of the hole, ensuring that the slide hammer is closed and the wire rope then marked with a line at 450mm spacing to show the driving distance. The sampler is driven into the soil by repeatedly lifting the sliding hammer approximately 760mm, the slide hammer length,

ensuring that it is never allowed to back hammer the sample tube during the test. The number of blows to drive the sampler for 450mm (the marked line) is recorded on the driller's log by the Lead Driller.

U100 sliding hammers

The sample should never be driven beyond 75 blows, if full penetration has not been achieved after these blows the total penetration should be recorded and the procedure abandoned. The sample recovered should be treated as that of a full recovery and waxed and labelled accordingly. Recovery of less than 100mm should not be retained in the sample tube but placed in a disturbed sample bag and labelled accordingly. The sample from the cutting shoe should be placed in a solid airtight container and labelled as a disturbed sample.

The sampler should be withdrawn slowly from the stratum. It may be pulled immediately from most soils, but in firm to stiff cohesive soils it should be left in the stratum for a few minutes to swell before it is removed from the hole. After withdrawal the sampler should be laid over the front cross member of the rig and the cutting shoe removed. If a liner is being used the liner can now be withdrawn from the barrel with pliers or grips. If a standard barrel is used the steel or aluminium tube is unscrewed from the sampler head. The sample should never be removed with the sampler suspended above the borehole. U100 samplers are unsuitable for obtaining representative samples in coarse grained soils, fine grained soils with a high granular content and Chalk.

The exact amount of sample recovered should be measured by the Lead Driller and this information entered on the driller's log. This may be recorded as either length or percentage. A small quantity of soil is then removed from either end of the tube with a small knife or shave hook to create a flat area of material and at least 2cms of space at each end of the sample tube. The sample must now be preserved as per Section 7.5 of this guidance.

The U100 can have a core catcher added to the shoe to increase retention of samples in difficult stratum. When the core catcher is added the driving length should be increased to 600mm, and recorded as such on the driller's log as this will seriously affect the quality of the sample.

If after withdrawal the sample tube is found to be empty, the U100 should be recorded as 'No Recovery' with the sample type U100F or UT100F. The borehole should now be advanced to the base of the unrecovered sample and taken as a disturbed sample over the depth of the sampling range. Once the hole is cleaned a second U100 should be attempted. Should a second 'No Recovery' be recorded a disturbed sample should again be obtained and an SPT should immediately be carried out at the base of the second failed sample.

Tight samplers may be back hammered out of the ground. The Lead Driller can choose to increase the blows if the hammer is below the water table.

7.3.2 UT100 Sampler

The UT100 sampler was developed in 2009 in anticipation of the introduction of BE EN ISO 22475-1 to the UK. This standard designated the U100 sampler (which had been in use in the UK for some 60

years) as delivering only a quality Class 2 sample when using a metal liner and potentially Class 3 when using a plastic liner.

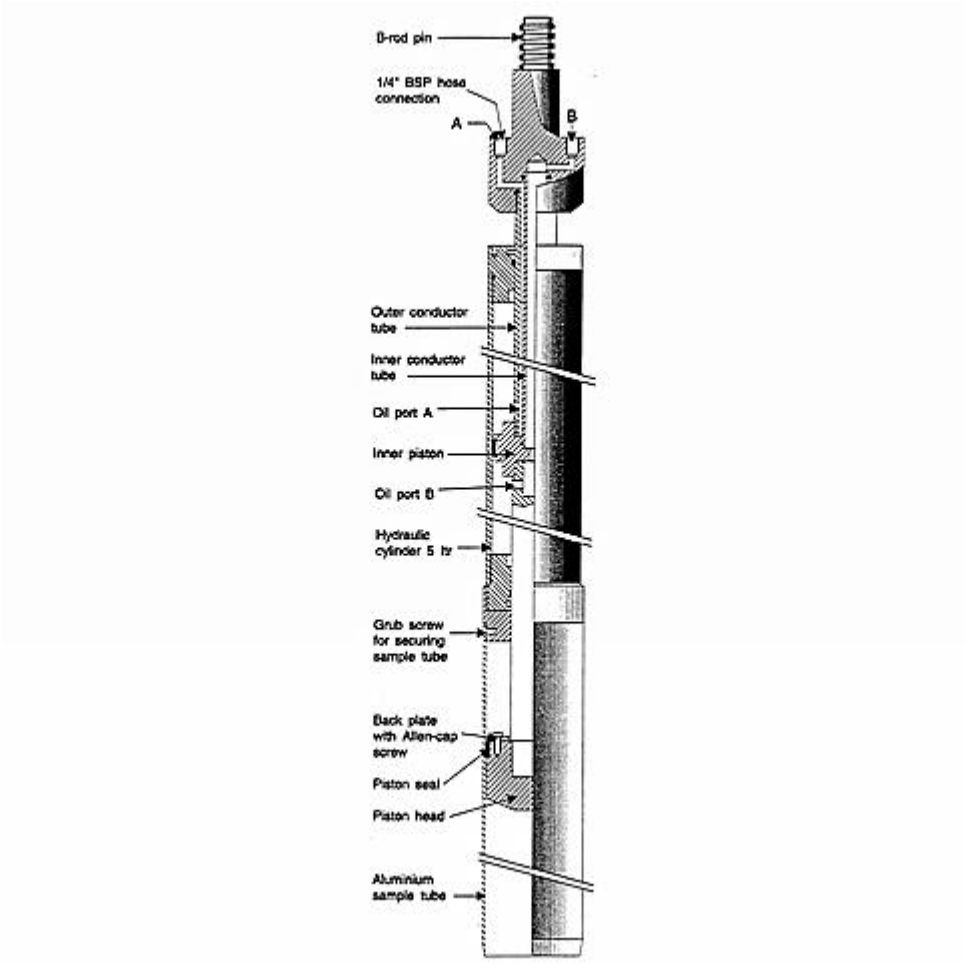
The UT100 sampler has a smaller area ratio of approximately 15%, which means that it conforms to the requirements of a quality Class 1 sample as described in the standard. The sampler may be used in fine grained soils within the medium to high strength range (40 to 150kPa). It is not intended for use in soils whose strength lies below or above this range, or indeed in soils that have a granular content. The use of the sampler in soils of either very high strength or having a granular content will result in the cutting shoe becoming damaged and unfit for future use.

In terms of driving the sampler, the same limitations that apply to the U100 also apply to the UT100. In other words excessive driving of the sampler should be avoided and as a guide sampling should not be attempted when the blows required to drive the sampler start to exceed 70 to 75.
UT100 samples should be handled, waxed, sealed stored and labelled in the same manner as standard U100 or liner samples. When undisturbed samples are required in very high strength or fine grained soils with granular content the standard U100 samplers should be used to remove the risk of damaged UT100 tubes and shoes and hence samples. However, as these U100 tubes have excessive area and length/diameter ratios, these samplers produce at best a Class 2 sample and cannot provide Class 1 samples which would be required for laboratory testing such as the triaxial type test and hence to provide soil properties relevant to in-situ conditions.

7.3.3 Piston Sampler

The hydraulic piston sampler is designed for taking undisturbed soil samples in very soft to firm clays. A typical proprietary example is described below. The unit is rigid and of fixed length, approximately 2.85 metres long, and is designed for use whilst held in a vertical, stationary position. The unit is typically supplied with a standard "B" rod male connection at its top end. Thin wall sample tubes are attached to the lower end of the hydraulic cylinder by means of three grub screws. The only moving part is the hydraulic cylinder and attached sample tube. The standard piston sampler has a stroke length of 1 metre and standard sampling tubes are 101.6mm i.d. 1 m long and have an area ratio of 7%. The necessary hydraulic load required for operation of the unit is usually generated from a hydraulic power unit. An oil flow rate of 20-25 litres per minute at 1500 p.s.i. is required for operation of the unit. The hydraulic power pack must have the facility for bidirectional flow of oil, as it is necessary to reverse the direction of oil flow during the normal operating procedure.

A reaction force, normally provided at ground level, is required. This can be a frame attached to the drilling rig or secured directly to the ground using anchors or bolts. In either case, the arrangement must be capable of producing enough resistance to the sampler as it is pushed into the ground.



Hydraulic Piston sampler

Prior to operation the compressible rubber seal on the piston head must be adjusted to give a good seal in the sample tubes. The fit of the seal can be adjusted by loosening or tightening the three cap screws on the back plate of the piston head.

The top of the piston sampler is attached to metal rods or the drill string using an appropriate adaptor. The hydraulic hoses are then connected between the sampler and the hydraulic power unit. The connecting rods/drill string is then attached to the reaction frame or drill rig. The intended depth of sampling will determine the length of the hydraulic hoses required. The attachment point of each hose to the piston is via threaded connections at the top end of the sampler.

Switch on the hydraulic power pack and experiment with the hydraulic controls to determine how the direction of oil flow influences movement of the hydraulic cylinder on the piston sampler.

Move the hydraulic cylinder to its lowest position so that the bottom of the cylinder is resting against the piston head.

Attach a clean sample tube to lower end of the cylinder by means of the 3 grub screws. In order to attain the best sealing conditions, grease should be applied to the upper end of the sample tube so that the rubber seal on the piston head is fully covered with grease when the sample has been taken. Now raise the hydraulic cylinder to its uppermost position so that the piston head comes to rest at the lower end of the empty sample tube, just above the chamfered edge.

Lower the entire unit until the open end of the sample tube is resting on the ground to be sampled. This is the STARTING POSITION and the rods must be locked and held stationary in this position.

Keeping the apparatus stationary, now reverse the flow of hydraulic oil so that the hydraulic cylinder descends, forcing the sample tube into the ground. Allow the hydraulic cylinder to descend to the maximum extent.

Better adhesion between the sample and sample tube is obtained by allowing the sample to rest in the sub-soil for about 5 minutes before withdrawing.

The entire unit is now raised from the ground by pulling back on the drill string at the connection point of the piston sampler. If the ground is tough the piston sampler may be rotated 1 revolution clockwise to help separate the sample from the underlying soil. The sampler must be taken up steadily without jolting or knocks.

The sample tube with enclosed soil sample can now be removed from the piston sampler by unfastening the 3 grub screws at the attachment point. Withdraw the sample tube slowly and carefully over the piston head and remove.

7.3.4 Shelby Tube Sampler

The Shelby sampler is a thin-walled soil sampling system. The system is used to sample soils that are particularly sensitive to sampling disturbance as it has a low wall thickness-to-sample area ratio typically 10% or less dependent upon diameter. The sampler consists of a thin walled steel tube whose lower end is shaped to form a cutting edge and is used in conjunction with a special drive head containing a relief valve.

Shelby tube

This sampler is usually only suitable for fine grained soils up to the upper end of the high strength category at 150kPa and free from large particles. This normally gives Class 1 samples of fine grained soils including sensitive clays. Samples of 75, 100 or 150 mm in diameter and of up to 1m in length can be obtained. The thin walled Shelby sampler is not fitted with a core catcher.

Ensure that the one-way ball valve is operating correctly and attach a clean sample tube to the lower end of the head by means of the 3 grub screws, ensuring that the cutting edge is free from any damage. Slowly lower the sample tube to the base of the borehole. Once in position the Shelby should be pushed into the soil by a continuous push which can be via simply pushing from the top or by means of a hydraulic jacking system. Once the full penetration is achieved the sampler should be left at the base of the borehole for a short period to allow the sample to swell within the tube. The entire unit is now raised from the ground by pulling back on the drill string. If the ground is tough the sampler may be rotated 1 revolution clockwise to separate the sample from the underlying soil. The sampler must be taken up steadily without jolting or knocks, especially with cohesionless soil.

The sample tube with enclosed soil sample can now be removed from the sampling head by unfastening the 3 grub screws at the attachment point.

Shelby tube and drive head

The sample should now be waxed and labelled and end caps placed on the tube. The borehole should then be progressed to the next sampling level and the cycle now repeated

7.4 Labelling of Samples

All samples shall be labelled immediately after being taken from the borehole. The samples shall be marked, so that there is no doubt about the upper and lower end of the sample. After sampling and sealing the sample, the label should be attached and show the following information as required by BS EN 22475: Part 1:

a) identification of the project;
b) identification of trial pit, borehole, etc.;
c) date of sampling;
d) identification of sample;
e) sampling category;
f) depth of the sample from reference level

In addition, BS 5930 and the AGS Data Format requires each sample to have a unique reference number.

Project	Buckley Hill Lane, Liverpool		
Project No.	P7248	Ref.	2
From	2.00	To	2.20
Hole No.	78	Type	ES
Sampled by	.	Date	16/03/16
GRM Development Solutions Ltd			

EQ0516031600 2

Example of a sample label

If they are to be preserved with their natural moisture content, they should be sealed in an airtight container or coated in wax at the same time

The sample is recorded on the daily field report. It should carry more than one means of identification so that the sample can still be identified if one label is damaged. The label should be marked with indelible ink and be sufficiently robust to withstand the effect of its environment and the transport of

the sample. If the sample is of potentially contaminated material or may contain hazardous substances, then the label should carry a warning to that effect e.g. coloured labels.

7.5 Sample Handling and Preservation

BS EN 22475: Part 1, The 'Yellow Book' UK Specification for Ground Investigation and BS 5930 all provide guidance on sample handling, storage and transport.

U100 shoe sample and U100 sample in a liner

All tube samples, U100, UT100, Piston and Shelby, should be placed upright (initially the correct way up) and the end of the sample waxed by pouring warm paraffin or bee's wax over the end of the sample. This should firstly be a thin layer to seal the sample then a 5mm plug added once the sample is sealed.

Once the wax has solidified a label should be placed on the wax and then the sample tube sealed with either plastic, or screw-threaded metal cap. The sample tube is then inverted and the waxing process repeated and the second cap fitted completely sealing the sample. This sealing must be carried out immediately, to prevent moisture changes in the sample. The sample should now be labelled with the top clearly identified. This is often done by placing the sample label nearest the top of the sample, the sample should now be protected from the environment wherever possible.

It is legal for gas bottles typically used to fuel burners for melting the wax, to be carried in vehicles as long as they are stored securely. The addition of a warning sticker to the rear of the vehicle, although not compulsory, is a sensible precaution. A risk assessment must be undertaken for the method of melting the wax and sealing the samples. Some sites may require hot works permits for melting the wax while other sites may forbid this altogether. On these sites the use of specifically designed electric wax melting baths should be used in a controlled area. The risks associated with the use of 'fire buckets' or open fires to melt wax are not acceptable.

The samples should be protected from frost, excessive heat and temperature variation, which could lead to deterioration in the sealing of the sample containers and subsequently damage the samples. The temperature of the sample store is influenced by the climate. BS EN 22475: Part 1 requires that the samples be stored at the lowest temperature practicable within the range 6ºC to 12ºC.

The steel tube is used as a container to transport the sample to the laboratory thus avoiding any damage to the sample.

Piston and Shelby samples should be stored vertically in custom made storage containers and very soft and soft samples should never be transported horizontally.

It should be noted that disturbance occurs at the base of the borehole in weak soil below a certain depth due to stress relief resulting from reduced over-burden pressure.

7.6 Environmental Samples

In addition to the samples taken for geotechnical purposes described above there may be a requirement to obtain samples specifically for chemical testing to allow an environmental assessment of the site to be made. This will be particularly relevant where sites are suspected of potential contamination.

Further information on site categorisations of potentially contaminated sites is given in Section 14.

Taking environmental samples introduces a number of additional requirements compared to geotechnical samples and is likely to vary between sites dependent upon the nature of the testing that is anticipated. These requirements should be defined in the relevant risk assessments and method statements and should be fully understood by the Lead Driller irrespective of whether he is required to carry out the sampling or, as is sometimes the case, this is done by the supervising engineer.

The method statements should address such matters as safe handling and avoiding cross-contamination and may include use of stainless steel sampling tools and washing equipment between samples.

Typically, an environmental soil sample (normally defined as sample type ES) will require to be taken in multiple containers, usually of different sizes and materials, which would normally be supplied by the laboratory selected to carry out the testing. The number and type of these may vary.

Environmental Water Samples (normally defined as sample type EW) shall be taken as instructed. Again, multiple containers may be required. Containers may be supplied already containing special chemicals needed for successful testing or the chemicals may be supplied separately and require to be added at the time of sampling.

In addition to the requirements for labelling of samples given in Section 7.4 environmental samples require that the time of sampling is recorded, as the results of many of the tests carried out are time-dependant.

Environmental Samples also require very different methods of storage and transportation compared to geotechnical samples.

All environmental samples must be placed in cool boxes supplied with ice packs immediately upon recovery. They MUST be kept cool at all times, either within the cool box or transfer to a refrigerator.

Environmental Samples will normally require to be sent to the designated laboratory at the end of each shift usually by a pre-arranged courier collection and must be accompanied by a completed Chain of Custody (CoC) form. Arrangement of collections and completion of the CoC would normally be the responsibility of the supervising engineer and not the Lead Driller.

7.7 In Situ Testing

7.7.1 Standard Penetration Test (SPT)

The SPT test and equipment is discussed in BS EN 22476: Part 3. The SPT test uses a split thick-walled sample tube, with an outside diameter of nominally 51mm and an inside diameter of nominally 35mm, and a length of approximately 650mm. The sampling tube has a 60^{o} cutting shoe attached to the bottom. The shoe should be screwed firmly into place, have a sharp cutting edge and be undamaged and not dented in any way.

SPT samplers and cones

This tool is lowered to the base of the borehole with straight rods which must be sufficiently stiff to prevent buckling and which have a mass not exceeding 10kg per metre (typically B rods), added as necessary, each firmly screwed together. Once seated on the base of the hole, from a fixed datum point the sampling rod should be marked with six narrow lines equally spaced 75mm apart so as to indicate any penetration. The hammer is then added to the string and any “Self-Weight Penetration” of the rods under just the weight of the hammer assembly recorded (SW).

If any penetration is recorded, the sampling rods should be remarked with the full test length (6 increments of 75mm). Should this penetration be in excess of 300mm, clarification from the Supervisor should be sought as this may result in a false value being obtained. The drill string is then driven into the ground by repeated lifting and releasing of the auto trip hammer by the Lead Driller and each blow recorded. The interval between blows shall be no less than 2 seconds.

The SPT hammer should have a mass of 63.5kg and fall through a distance of 760mm. The complete hammer assembly should weigh in total no more than 115Kg. It shall be clean, well maintained and used without lubrication. The sample rods must be centralised within the borehole before the test begins and they should not be forced to one side or allowed to move freely.

SPT drop hammer

The number of blows needed for the SPT tool to penetrate each 75mm increment up to a depth of 450mm is recorded. The number of blows required for the first two increments is described as the “seating blows” and the sum of these seating blows should not exceed 25 blows. Once this number is reached the penetration should be recorded (mm) and the sampling rod remarked with the last four increments.

The last four increments (300mm distance) of penetration are termed the "standard penetration resistance" or the "N-value" (N). In cases where 50 blows are insufficient to advance the test through this full 300mm interval the penetration (mm) achieved with 50 blows is recorded i.e. 50 for 200mm. Blows in excess of 50 should never be carried out using the split spoon sampler. Where double hit or bouncing occurs or there is no penetration for 25 blows the test should be aborted and the total penetration reported and test ‘refusal’ noted.

SPT rods marked up for a test also showing the centralising collar

If carrying out SPTs below the water table, the water level in the borehole must be maintained at a sufficient level above the ground water level to prevent any entry of water through the base of the borehole.

The total blows for the test may be increased to 100 blows, at the Supervisor's discretion. However, Designers should question the value of SPT tests in excess of 50 blows and even more so tests of 100 blows for use in design and instruct with due consideration. Driving SPTs in excess of 50 blows dramatically increases the risks of damage and or loss of the SPT equipment and Supervisors should consult with the Lead Driller to discuss a sensible termination for the test.

Where the stratum is either coarse grained soil or rock the split spoon should be replaced by a cone (SPT/C) this cone should wherever possible be solid to prevent damage. The cone is fitted to a solid rod of approximately 650mm in length and should be smooth edged, pointed and not rounded and must have a 60^{o} cone angle. The test procedure is exactly as that for a SPT, described above. The cone should not be used in fine grained materials. Where a solid rod is not available the SPT shoe can be replaced with a screw on cone.

SPT cone

The blow count provides an indication of the strength of fine soils and the relative density of coarse grained soils, and it is used in many geotechnical engineering formulae and its importance cannot be overestimated. Accurate measurement and blow counts are often critical to design. The entire sample from the split spoon sampler should be placed in a suitable air tight container and be labelled immediately and protected from the environment as far as is practicable.

Liner style SPT barrels are available and if used, the sample should be sealed into the liner by means of caps and labelled and stored accordingly. Where the split spoon does not recover a sample it must be recorded as 'No Recovery' (NR) on the drilling log. Where a cone penetration test has been carried out a bulk sample should be taken over the range of each test and labelled accordingly.

The record of the SPT must be entered on the driller's log and must include the following information

- Test start depth
- Water level at start of test
- Casing level at start of test
- Self-Penetration recorded
- Seating blows and any corresponding penetration
- Main test blows and any corresponding penetration
- Total length test was driven

Examples of Recording SPT

Sample	Depth (m)		Standard Penetration Test										Casing	Water
Type	From	To	Self-penetration weight (mm)	75	75	PEN (mm)	75	75	75	75	PEN (mm)	N	Depth, (m)	Level, (m)
SPT	2.00	2.60	150	1	0	150	1	0	1	0	300	2	2.00	Dry

Example showing Self Penetration

Sample	Depth (m)		Standard Penetration Test										Casing	Water
Type	From	To	Self-penetration weight (mm)	75	75	PEN (mm)	75	75	75	75	PEN (mm)	N	Depth, (m)	Level, (m)
SPT	3.00	3.45	0	3	4	150	4	5	7	9	300	25	3.00	2.15

Example showing full penetration of SPT

Sample	Depth (m)		Standard Penetration Test										Casing	Water
Type	From	To	Self-penetration weight (mm)	75	75	PEN (mm)	75	75	75	75	PEN (mm)	N	Depth (m)	Level (m)
SPT	10.30	10.61	0	10	15	150	15	15	20	-	160	-	9.00	6.72

Example showing SPT refusal with the third test drive increment being 20 blows for 10mm

7.7.2 Health and Safety whilst taking SPTs

Care must be taken when lifting this heavy hammer into and from the testing position. The hammer shall have a safety lifting pin which passes through the shaft and lifting sleeve which keeps the anvil and hammer closed tightly together when lifting, preventing entrapment. The pin should only be removed after the anvil has been lightly attached to the drill string via the thread of the rods. The pin is then removed and the anvil carefully screwed home. Care must be taken to ensure that the Support Operative at no time places his finger above the level of the top of the anvil. This operation should be repeated in reverse for removing the trip hammer. The use of a chain to keep the hammer and anvil together is not acceptable as the hammer and anvil cannot be held close enough together to prevent entrapment between the two parts. Do not tighten the anvil whilst hammering is still continuing.

Ear protection must always be used when using the trip hammer The Support Operative should stand well clear of the borehole area whilst the hammer is operating and only approach the borehole area after instruction from the Lead Driller. The use of a rope or similar operated by the Support Operative to re-attach the sleeve to the hammer should never be used.

The Auto hammer must carry unique identification for both SPT energy measurement and lifting inspection under LOLER (Lifting Operations Lifting Equipment Regulations 1998). The hammer's energy ratio as defined in BS EN 22476: Part 3 must also have been measured and a certificate available to the engineer before normalisation of the blows can be made. The unique ID of the hammer along with the Energy Ratio (Er) reading must be displayed on the driller's log. A current (6 monthly) lifting examination record of the lifting sleeve must also be available.

The use of threaded or welded subs in the base of the anvil should be avoided at all times. The SPT hammer should screw directly onto the drill string.

7.7.3 Borehole Vane Shear Test

The borehole vane shear test is an in-situ testing method used to obtain the undrained shear strength of fully saturated clays without disturbance. The test is relatively simple, quick, and provides a cost-effective way of obtaining the soil shear strength; therefore, it should be more widely used in geotechnical investigations. The results of the test are less reliable if the clay contains significant percentages of sand and/or gravel.

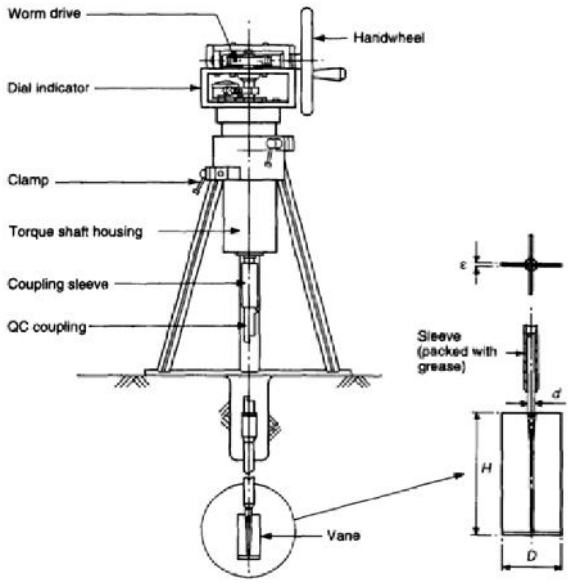
The borehole vane shear test apparatus consists of a four-blade (cruciform) stainless steel vane attached to a steel rod that will be pushed into the ground. The height of vane is usually twice its overall width and is often equal to 10 cm or 15 cm.

The borehole vane shear test consists of pushing the vane, mounted on a solid rod, into the soil and rotating it from the surface. In all tests, it is important that the vane is pushed ahead of disturbance caused by any drilling operations. The vane should, wherever possible, be advanced at least five borehole diameters ahead of the bottom of the borehole.

Push the vane slowly with a single thrust from the bottom of the borehole for the distance required to ensure that it penetrates undisturbed soil. Ensure that the vane is not rotated during this stage.
Attach a purpose-built geared drive unit, (see below) to the top of the vane rods and secure in place to the top of the borehole using the casing clamp of the drive unit. Now turn the rods at a slow but continuous rate via the hand wheel. BS 1377 specifies a vane rotation rate of 6° to 12°/min.

Record the relationship between rod rotation and measured torque taking readings of both at intervals of 15 seconds.

Once maximum torque is achieved, and the strata shears, rotate the vane rapidly through a minimum of ten revolutions, and allow to rest for 1min before restarting shearing at the previous slow rate, to determine the remoulded strength of the soil.



Example of borehole vane equipment

7.7.4 Permeability Test

The permeability of a stratum can be determined in situ by variable or constant head tests. The most common tests in Cable Percussion boreholes are variable head tests and these can be either rising or falling heads.

The methodologies for permeability tests carried out in a borehole using open systems are described in detail in BS EN ISO 22282: Part 2.

The equipment required comprises:

- For a falling head test - clean water in a container with sufficient water to raise the water level and suitable pouring device.
- For a rising head test - bailer, pump.
- Wristwatch or stop watch accurate to the second
- Dipmeter
- Data entry form (see example below)

The borehole and/or response zone should be cleaned as far as practicable prior to testing, and the water level should be left to stabilise following drilling or sampling and prior to carrying out the test.

A test may be required to be carried out as an 'open end test' i.e. where the borehole is cased to full depth, or by withdrawing the casing to expose the side wall of the borehole for a specified length to produce a 'test section'.

In the latter case, if the borehole is constructed in non- stable materials suitable coarse gravel filter material should be placed inside the casing and the casing then withdrawn to the top of the filter.

Before starting the test, the following must be recorded.

- The dimensions of the test zone. For tests in boreholes this requires the depth and diameter of borehole and casing. For tests in installations it requires the depth to top and base of response zone and its bored/drilled diameter.
- The diameter of the conduit in which the water levels will be measured; for tests in boreholes this means the casing and for tests in installations it means the standpipe tubing.
- The height above ground level of the datum from which water levels will be measured during the test, i.e. the "stickup" of the borehole casing or standpipe tubing.
- Groundwater prior to the test both as 'm below ground level' and as 'm below top of casing/tubing' (the difference between the two should equal the "stickup").

To carry out the test the water level is raised by pouring/pumping in clean water (falling head test) or depressed by bailing/pumping out (rising head test).

In theory the initial change in water level should be instantaneous, and during the test there should be no significant fluctuation in water levels outside the borehole/installation. This means that the initial change of water level should be as rapid as possible, and that pumping or filling over a period of more than a few minutes should generally be avoided. The change in water level needs only to be measurable, so the borehole does not need to be completely empty or full to complete the test.

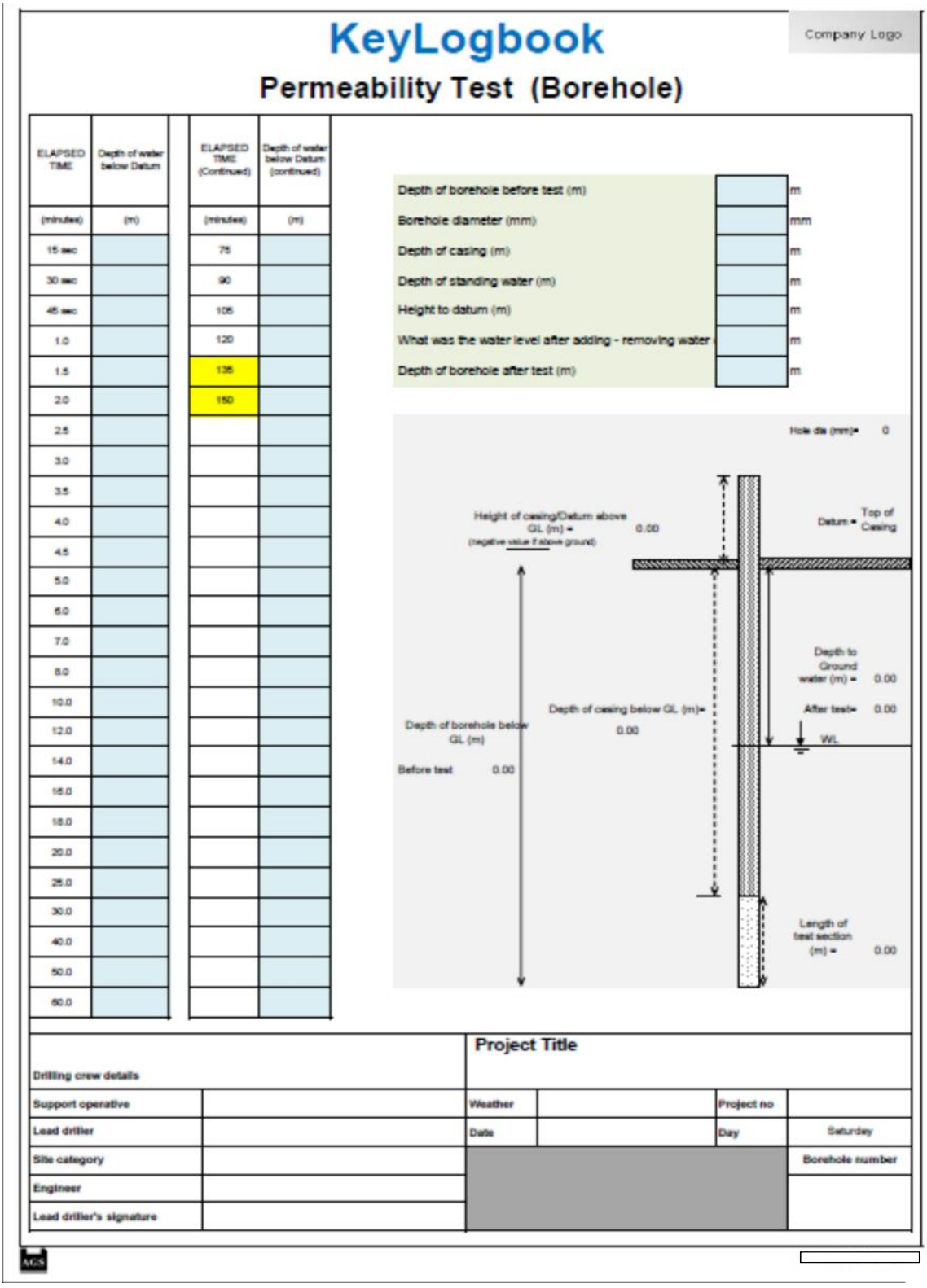
Care should be taken to ensure that no contaminated water removed is discharged directly or indirectly into a watercourse or drain. If the water is contaminated and is not needed as a sample, it is preferable to carry out tests that do not involve removing water from the hole to avoid problems of disposal.

The water level is recorded at intervals of time. For the purpose of calculation, time zero is when the first water level is recorded NOT at the time pouring in/bailing out stops. Thereafter a suggested set of elapsed times is:

0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 40, 50, 60 minutes.

If it is not possible to take a reading at the specified time, record the actual elapsed time at which the measurement is made. The timing of readings depends to some extent of the permeability of the soil being tested. In a soil of relatively high permeability it helps with the interpretation of the test if more than two reliable measurements can be taken in the first minute and the initial reading should be at 15 second intervals for 2 mins. It may also be necessary to extend the initial period of 30 second intervals to more than 3 mins.

Ideally the test should continue until the equilibrium water level is achieved and there are 3 readings with no change in the water level at this point the test should be terminated this is not always practicable in soils of low permeability. In low permeability strata it may be necessary to continue the test beyond 60 minutes.



KeyLogbook

Company Logo

Permeability Test (Borehole)

ELAPSED TIME	Depth of water below Datum
(minutes)	(m)
15 sec	
30 sec	
45 sec	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
6.0	
7.0	
8.0	
10.0	
12.0	
14.0	
16.0	
18.0	
20.0	
25.0	
30.0	
40.0	
50.0	
60.0	

ELAPSED TIME (Continued)	Depth of water below Datum (continued)
(minutes)	(m)
75	
90	
105	
120	
135	
150	

Depth of borehole before test (m)		m
Borehole diameter (mm)		mm
Depth of casing (m)		m
Depth of standing water (m)		m
Height to datum (m)		m
What was the water level after adding - removing water		m
Depth of borehole after test (m)		m

Hole dia (mm)= 0

Height of casing/Datum above GL (m) = 0.00
(negative value if above ground)

Datum = Top of Casing

Depth to Ground water (m) = 0.00

After test= 0.00

WL

Depth of casing below GL (m)= 0.00

Depth of borehole below GL (m)

Before test 0.00

Length of test section (m) = 0.00

Drilling crew details		Project Title			
Support operative		Weather		Project no	
Lead driller		Date		Day	Saturday
Site category					Borehole number
Engineer					
Lead driller's signature					

AGS

Example of a permability test record

SECTION 8

INSTALLATIONS

8.0 Installation Types

There are many types of installation which can be installed in a Cable Percussion borehole including piezometers, standpipes, gas monitoring wells, water wells, inclinometers and extensometers.

Piezometers and standpipes are commonly used to obtain groundwater measurements such as piezometric head or simple water levels. Gas valves can be installed at the top of some of these installations to allow gas monitoring and gas samples to be obtained from the borehole.

Larger diameter wells can also be used for water sampling and where Cable Percussion boreholes are used in water well drilling, submersible pumps can be installed to abstract water.

Inclinometers and extensometers are used to monitor ground movement or displacement within the borehole.

This guidance provides an overview of the most common installations but further information can be obtained in the UK Specification for Ground Investigation and on supplier and manufacturer's websites.

8.0.1 Piezometers

Piezometers, otherwise known as Standpipe Piezometers or Casagrande Piezometers, are a method of obtaining a discrete measurement of water pressure from a specific zone. Typical piezometers are made up of low air entry porous plastic or ceramic elements which are connected to standpipe tubing, normally plastic, and lowered into a predrilled borehole. Alternative types may be driven or pushed into soft soil and these would typically use steel tubing and tips to improve robustness and rigidity.

Other types of piezometer include vibrating wire, pneumatic and hydraulic, where the tip is connected to the surface using cabling or capillary tubing. Only trained installers should complete installations using these other types of piezometer.

Where Casagrande type piezometers are being installed, the porous element is surrounded by filter sand and a bentonite seal placed above and below this response zone. This filter sand should be well graded to ensure good permeability and hydraulic connectivity with the instrument. Builder's sand such as sharp or soft sand is unsuitable for use as piezometer filter sand. Water level measurements are normally taken using a water level meter (dipmeter) or in the case of artesian pressure a Bourdon pressure gauge is attached to the top of the access tubing.

Ceramic

Drive in

Standard Casagrande

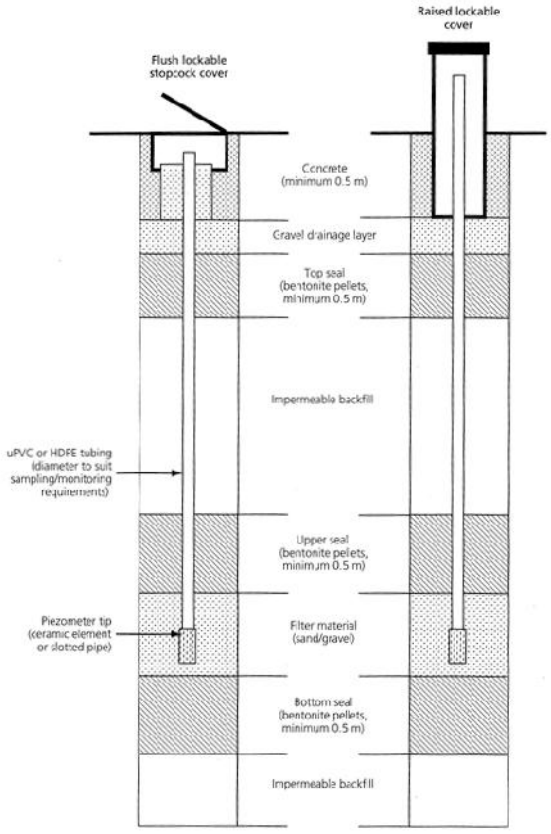
Stand**pipe piezometer tips**

Ceramic tips must be soaked for 24 hrs before use to eliminate trapped air from within the element.

Dipmeter

The installed depth of the piezometer is usually taken to be from ground level to the bottom of the tip. Therefore, when specifying borehole depth, allowances must be made for the length of the sand cell around the tip.

A piezometer is normally completed at surface with either a concreted stopcock cover or upright cover for security and to prevent surface water ingress.



8.0.2 Standpipes

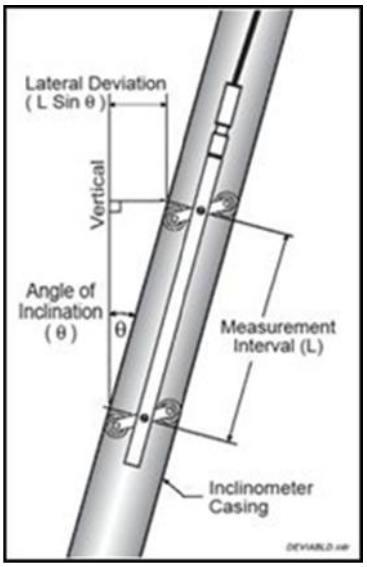
Standpipes or Monitoring Wells are generally installed to obtain water levels from a longer response zone which can be several metres or even tens of metres in length. Standpipes are typically installed where a simple groundwater regime exists, and the measured water level refers to a certain region rather than a discrete zone.

A standpipe often consists of a perforated/slotted pipe (screen) at its lower end surrounded by filter material and plain pipe (casing) in the upper section. The pipe is usually either PVC or HDPE but stainless steel pipe is often used for water wells. The pipe is inserted into the borehole and the annular space between the screened section and the corresponding borehole wall is normally packed with sand or fine gravel. The size of the slots and grading of the filter material can vary depending upon the ground conditions and final requirements of the installation. The annulus at the base of the plain section is filled with bentonite to form a seal and the borehole is completed with grout or backfill to surface where headworks are installed. These may vary from stopcock covers or upright covers to manhole chambers and covers for wells.

Over time this type of installation may result in silting in the pipe and thus a reduction in the performance of the installation. Slotted/screened sections can be wrapped in geotextile to reduce silting up within the pipe and in wells purging can be carried out.

8.0.3 Inclinometers

Inclinometers may be installed in Cable Percussion boreholes. They are used to detect lateral displacements and shear planes in excavations, tunnelling and both natural and manmade slopes. A sacrificial casing with orthogonal grooves is installed in a grouted borehole with one set of grooves aligned in the assessed direction (A) of principal displacement. A wheeled probe with orthogonal tilt sensors is placed inside the casing with the wheels in the (A) groove. The tilt sensors record the angle of inclination at 0.5m intervals and the results are summed from the bottom to calculate the profile of the casing. Subsequent readings of the casing are compared with the initial profile to calculate the relative displacement over time.



Inclinometer instrument within inclinometer casing

Inclinometer casing is nominally 70mm diameter and is sealed at its base with a plug. During installation it is essential that no debris falls inside the casing. In boreholes with water present, the inclinometer casing will initially float but as it is pushed below the water will tend to rise back out. Normally filling the inclinometer casing with clean water allows the installation to counteract the buoyancy effect.

Inclinometer casing showing grooves

QC Type inclinometer casing

It is good practice to run a dummy probe down an inclinometer immediately after installation to ensure that the grooves are all aligned and no casing has parted during installation. The dummy probe should be an old unit or one without sensors as these can be lost in a poor installation.

8.0.4 Extensometers

Extensometers can be of rod or magnetic type but magnetic are the most commonly installed in Cable Percussion boreholes. Extensometers are used for measuring vertical displacements in boreholes either within discrete horizons or throughout the whole depth of the borehole.

A magnetic extensometer comprises a hollow access tubing with one or more spider magnets placed at the required measurement depths. The spider magnets comprise donut shaped housings typically enclosing three radially spaced magnets with sprung legs protruding from the housing. When activated the spider magnets embed themselves into the soil.

This is generally satisfactory in soft soils but should not be relied upon in stiff soils, such as those typically found in embankments and slopes. The extensometer tubing should be installed to a sufficient depth where a datum magnet can also be installed, usually at the base, to provide a set of stable readings to compare with any movement detected in the spider magnets above. Depth measurements are taken using an instrument called a Reed Switch Probe which is similar to a dipmeter but has a tip which detects the magnets and then sends an audible alarm. As well as readings for the depth to the spider magnets and datum magnet, surface level readings should also be taken.

Spider magnets and reed switch probe

Where both vertical and lateral movements are expected in a borehole, some suppliers provide spider magnets which can be installed around inclinometer casing which is larger than normal access tubing.

8.1 Installing Piezometers and Standpipes

The installation steps below are provided for installations with filter zones and bentonite seals. It should be noted that there is good evidence and studies that fully grouted (cement-bentonite grout) piezometers, particularly of the vibrating wire and pneumatic type, work equally as well and sometimes better as they are less complicated to install. For them to be successful, the grout mix must be designed and specified to suit the anticipated permeability.

Notwithstanding the above, the most common piezometers and standpipes specified required bentonite seals and filter zones and a simple set of steps to achieve a good installation are provided below:

1. Ensure the final borehole depth is as specified using a weighted measuring tape.
2. Ensure that no slurry or drilling material is present in the borehole as this will contaminate and block the standpipe and or tip filter element. If present, clean out the borehole by bailing or flushing with clean water immediately before installing.
3. Check/determine the precise depth to the bottom of drill casing (if present).
4. If a seal is required at the base, pour clean bentonite pellets to the base of the borehole. If water is present allow time for the pellets to settle through the water column and check depth frequently with a weighted tape measure. If no water is present, then water must be added to the bentonite in order for the bentonite to swell and create the seal. This should be done in a slow and steady manner to avoid the bentonite bridging within the borehole.
5. Check that the base seal is a minimum of 0.5m thick or to the depth specified.
6. Pour clean filter material (sand or gravel) onto the bentonite seal. If water is present then allow to settle again and check depths. Tamp the sand to form a firm base, ensure total depth is as specified using a weighted measuring tape. Some installations may have a blinding layer directly on top of the bentonite seal which is typically sand.
7. The filter must cover the bentonite seal by a minimum of 100mm before installing the tip or standpipe.
8. Connect the piezometer tip to the first length of standpipe tubing using the appropriate coupling supplied or start to thread together the pipe sections of the standpipe.
9. Lower the pipework down the borehole making additional connections until the bottom of the standpipe or piezometer tip reaches the sand filter.
10. Push an end cap over the standpipe tube to prevent accidental entry of soil, fill and debris and to prevent subsequent blockages.
11. Slowly pour clean filter material until it has surrounded the piezometer tip or slotted section of the standpipe.
12. The filter must extend to a minimum of 100mm above the top of the piezometer tip or screen section.
13. Allow the sand to settle before taking a depth measurement with a weighted measuring tape
14. The Lead Driller should ensure no filter material is placed inside any casing present. Withdraw the casing, if present, until the bottom of the casing is approximately 0.3m above the top of the filter.
15. Once the filter material is placed to the top depth, slowly pour bentonite pellets to create the top seal. If the bentonite is placed dry water should be added and time allowed for the bentonite to hydrate.
16. Withdraw further sections of casing, as necessary, as the bentonite plug is formed.
17. Check total depth is as specified using a weighted measuring tape (if no water is present in the hole water must be added to the bentonite in order for the seal to be formed correctly).
18. Ensure the top seal is a minimum of 0.5m thick or to the depth specified.
19. Backfill the borehole with grout or specified backfill material, withdrawing the drill casing as the backfilling proceeds. Constantly check the depth during backfilling to ensure no bridging is taking place (using a weighted measuring tape). If grout is used, time must be allowed for grout to solidify before completion of the installation. When grouting is required refer to installation instructions for strength mix. It will vary dependant on the installation type. Grout should always be tremmied in and pumped from the base.
20. Take a reading of the piezometer by means of an electronic dip meter to ensure the instrument is working correctly and record the water level and time of reading.
21. Check that the installation is completed with a top bung (gas installation) or cap.

22. Construct headworks as specified. A drainage layer must be installed below the cover and installations prone to flooding from surface water should have a drain fitted through the concrete into the drainage layer. The cover should never be fitted directly onto the bentonite seal. Concrete should be no less than 0.50m cube and be a 4:1 gravel cement mix. Covers should be installed open and closed and locked (where possible) after installation of concrete.

SECTION 9

REPORTING REQUIREMENTS

9.0 Collecting the Data

If Cable Percussion drilling is being carried out, it is essential to recognise that the person responsible for the operation of the rig, i.e. the Lead Driller, not only has the responsibility of constructing the borehole, obtaining samples and carrying out tests but that he must also report accurately and completely everything relevant.

The essential thing to remember is that the principal objective of the drilling, sampling and testing is to produce information for use in design, as well as samples. Reporting of Cable Percussion drilling is required for each shift, and is made in the form of a Driller's Log, an example of which is shown in Appendix F. Whilst historically these forms have been handwritten on paper sheets increasingly electronic systems, typically using ruggedized tablet computers, are used. These offer numerous advantages over paper-based reporting and BS 8574:2014, the code of practice for the management of geotechnical data for ground engineering projects, encourages their use by stating the following:-

"Data should be collected at source, entered once and retained electronically e.g. in a computer system".

The document also states that "if it is not possible to log data electronically at the source of collection, the data should be recorded manually in a paper-based format only once, and then entered into a computer system".

The BDA supports and recommends the use of electronic data capture at source i.e. by the Lead Driller, as it offers many advantages including improved efficiency and reduction in errors or missing information.

9.1 Driller's Log

Irrespective of whether electronic or paper based reporting is used, BS 5930 specifies the data which must be reported daily on the Driller's Log from Cable Percussion operations as follows:-

- Contract Name and Number
- Crew Names including CSCS/BDA audit details
- Borehole Number
- Day/Date
- Rig and Equipment details
- Borehole depths and diameters (which should form a complete record of both without gaps or overlaps)
- Water added depths, amount
- Strata depths and descriptions
- Samples including types, depths, recovery, blows, casing, water level (as applicable)
- In situ tests – depths and details
- Depths and times of hard strata/chiselling
- Groundwater levels including times
- Installation details
- Backfilling/reinstatement
- Standing/Dayworks (i.e. when not advancing borehole) including details, start time and duration)
- Aquifer protection seals, depths and diameter

SECTION 10

REINSTATEMENT

10.0 Site Clearance

It is essential that the responsibility for final reinstatement is clearly defined. Nonetheless, when the Cable Percussion drilling activity is completed, it is vital that the site is immediately restored to a safe and satisfactory condition with no hazards left that would be of potential harm to the public, animals or environment. This includes situations where the Cable Percussion hole is left available for subsequent activities such as rotary follow-on drilling or monitoring or testing by others.

The drilling crew should clear each borehole location of slip or trip hazards and dispose of waste to an appropriate location i.e. site skip. Areas should be left secure i.e. gates shut or fencing closed. Any excess materials or resources should be returned to the site compound or back to the contractor's yard.

10.1 Borehole Backfilling

Every completed or uncompleted borehole should be fenced or temporarily capped or covered in a safe manner while the rig is standing over or has moved off the finished hole, and until the borehole is finally and permanently capped or reinstated.

Unless a borehole is required to be kept open for a specific purpose, it should be infilled, consolidated, capped and or reinstated in such a manner that there will be no subsequent depression at ground level due to the settlement of the infill material.

Boreholes should normally be filled with arisings, cement or bentonite mixtures. If the hole is to be grouted the mixed grout should be placed through a tremie pipe to the base of the borehole, which is slowly raised as the grout is placed.

Boreholes should be sealed to prevent water ingress into underground services and tunnels etc. If grout shrinkage could cause water ingress, then the use of bentonite/cement grout is recommended rather than just bentonite.

The Lead Driller should record on the daily log sheets full details of the mix used and depths of placement. Any grout loss and the net volume placed should also be recorded.

In areas where livestock are present or settlement is anticipated which would cause a hazard, capping pads should be considered and, if required, placed at least 1 metre below ground level and then the hole backfilled to surface.

Boreholes containing installations should be completed with lockable stopcock covers or raised lockable covers or for larger diameter installations manhole chambers and covers.

10.2 Highways Reinstatement

All public road and footpath repairs should be in accordance with the requirements of the Highway and Utilities Council (HAUC) Report, which is the approved code of practice under the New Roads and Street Works Act.

The New Roads and Street Works Act requires that those who carry out the manual excavation and reinstatement in the Highway (roads and footpaths) are qualified for the activities being carried out. Any street works site must have at least one qualified NRSWA Street Works Operative on site at all times during works, and the site must have a qualified NRSWA Street Works Supervisor appointed to the site who can oversee the works.

SECTION 11

RIG AND EQUIPMENT SAFETY REQUIREMENTS

11.0 Machinery Directive and Compliance

The HSE advise that since 1995 all new machinery within the scope of the EU Machinery Directive has to be designed and constructed to meet common minimum European requirements for safety. The outward signs of compliance are CE marking on the equipment and a document (Declaration of Conformity) issued by the Responsible Person (normally the manufacturer) declaring the product's conformity. To achieve compliance the Responsible Person must undertake a conformity assessment process to meet the Directive's obligations. This includes meeting all relevant essential health and safety requirements (EHSRs) for the product, producing comprehensive user instructions, and showing how compliance has been achieved in the technical file. For certain higher risk products, such as safety devices, the conformity assessment process will require the use of an independent Notified Body.

These requirements have been implemented in the UK by the Supply of Machinery (Safety) Regulations, as amended by the Supply of Machinery (Safety) (Amendment) Regulations. In addition to machinery these requirements also apply to interchangeable equipment, safety components available independently on the market, lifting accessories, chains, ropes and webbing, removable transmission devices and partly completed machinery.

Drilling rigs, including Cable Percussion rigs, must be manufactured in accordance with the Machinery Directive and harmonised standards but in particular BS EN 16228 Drilling and Foundation Equipment Safety.

The Health and Safety at Work Act and Regulations, such as LOLER and PUWER, place a duty directly on employers and users of equipment at work to ensure that, as far as reasonably practicable, they only select and put into service machinery which is safe and compliant, well maintained and serviced.

11.1 Rig Examination Report (LOLER)

The Lifting Operations and Lifting Equipment Regulations (LOLER) define lifting equipment as "work equipment for lifting or lowering loads and includes its attachments used for anchoring, fixing or supporting it".

Cable Percussion rigs are covered by these regulations.

Regulation 9 of LOLER covers thorough examinations and inspections and requires that the Cable Percussion rig is thoroughly examined in accordance with an examination scheme drawn up by a competent person, or, in the absence of such an examination scheme, at least every 12 months.

The drilling rig must be accompanied by physical evidence, e.g. a certificate to the effect that the last thorough examination has been carried out.

The Drilling Rig should be inspected in two parts:

1. The winch with a SWL of winch and brake
2. The main frame which would have a much higher SWL normally 2 or 3 times the SWL load of the winch.

11.2 Lifting Accessories Examination Report (LOLER)

Regulation 9 of LOLER 1998 also requires accessories for lifting, the new generic name for shackles, swivels, etc., be subject to a regular examination scheme by an independent competent person, or, in the absence of such an examination scheme, accessories for lifting have to be examined by a competent person every 6 months. In the case of Cable Percussion drilling, any component with an integral lifting eye e.g. sinker bars, snatch blocks, rod swivels and clevis pins is subject to Regulation 9.

The drilling accessories must have available physical evidence i.e. a certificate to the effect that the last thorough examination of accessories has been carried out.

All lifting accessories must have sufficient load carrying capacity for the operation to be undertaken safely and should be marked with their safe working load (SWL) and a unique identification mark.

11.3 Wire Rope Requirements and Inspection

Regular inspection of wire ropes in service is essential if a high standard of safety is to be achieved. Wire ropes are required to meet the requirements of LOLER. A thorough inspection of all wire ropes in use should be made before each shift by a competent person, and the results recorded and be readily available.

BS EN 16228 requires that wire ropes used for Cable Percussion drilling should be able to withstand the applied load and have a Factor of Safety of 5.0 applied. Appendix C, Table 1 has been extracted from BS EN 16228 and provides details of the number of grips required, torque requirements, weights and applicable SWL of different wire rope sizes (diameter). End termination types are also specified in BS EN 16228.

In order to prevent suspended tools from backing off (back-screwing of thread) left hand lay rope must be used.

Any deterioration resulting in appreciable loss of original strength, such as any of those described below, found during an inspection should be recorded and the wire rope discarded or the damaged part removed.

- Reduction of wire rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires
- In any length of diameters, the total number of visible broken wires matches or exceeds the figures given below
- Corroded or broken wires at the end terminations
- Corroded, cracked, bent, damaged, worn or incorrectly fitted end terminations
- Severe kinking, crushing, cutting or un-stranding
- Heavy wear and / or broken wires may occur in sections of the wire rope in contact with equaliser sheaves or other sheaves where rope travel is limited, or with saddles. Particular care should be taken when inspecting ropes at these locations

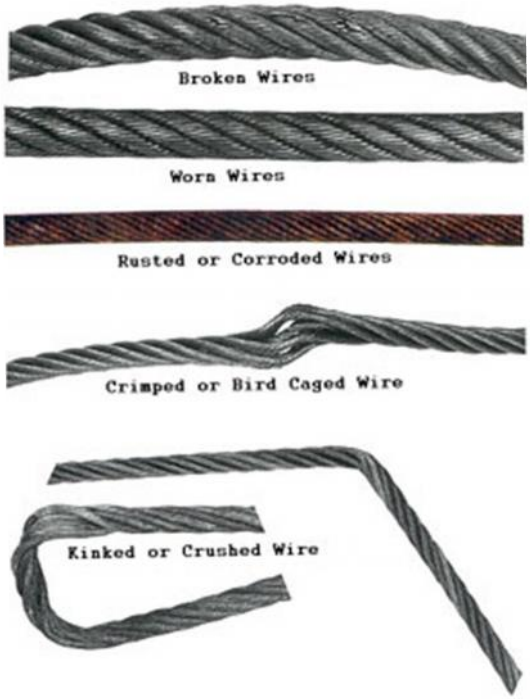
Regarding wire rope discard criteria, the table in BS ISO 4309 gives the following: -

For rope with Rope Category Number (RCN) 4 and a nominal diameter of 13mm

In a 78 mm length (i.e. 6 x 13)	5 visible breaks
In a 390 mm length (i.e. 30 x 13)	10 visible breaks

For rope with Rope Category Number (RCN) 4 and a nominal diameter of 16mm

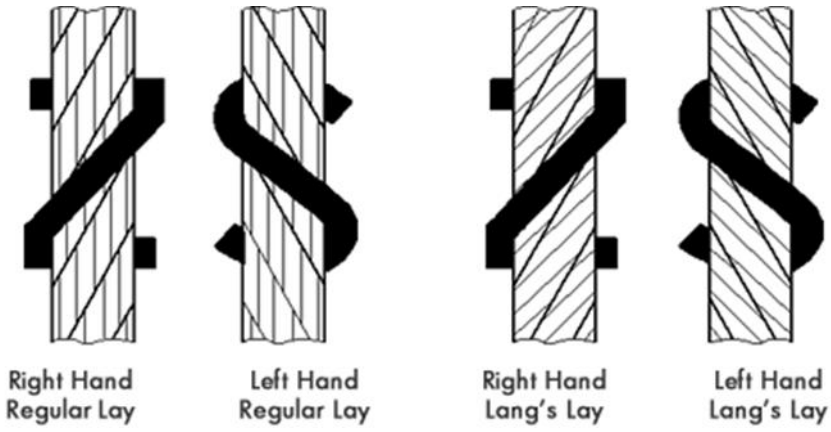
In a 96 mm length (i.e. 6 x 13)	5 visible breaks
In a 480 mm length (i.e. 30 x 13)	10 visible breaks



Examples of damaged wire rope

The standard defines the nominal rope diameter as 'the designated diameter of the rope', i.e. 13 mm or 16 mm. When wire rope is removed from service due to defects, it should be clearly marked or identified as being unfit for further use and discarded in an unusable form.

When fitting a replacement wire rope, ensure that it is of the same type and specification recommended by the manufacturer. The type of rope should be a left hand lay fibre core rope and of the correct safe working load to match the SWL of the rig, including for a Factor of Safety of 5.0 as specified in BS EN 16228.



Care should be exercised when installing new wire ropes on winch drums and over pulley wheels, in order to ensure that there is even tension on the new rope being pulled round the system. Sharp bends should be avoided and the rope must be kept clear of dirt and abrasive materials. The wire rope should never rub against any part of the rig A frame.

The rope should be kept tensioned and evenly wound on to the winch drum.

Example of correctly laid wire rope

When the rope is being wound on to the drum it should not be touched by hand without protective gloves being worn. On Cable Percussion rigs, in order to prevent crushing the rope, where a drum divider is used, there should not be more than four turns on the working section when the drilling tool is at the deepest point. Overruns should be avoided by correct winch operation.

The rope should be securely fastened to the drum as specified by the rig manufacturer, and a minimum of three turns of rope kept on the drum at all times.

Whenever possible, new wire ropes should be run in under light load for a short period after installation in order to allow for adjustment to working conditions.

All wire ropes should be thoroughly lubricated with suitable wire rope dressing and kept lubricated during their working life.

Rope end terminations i.e. sockets, rope grips, eyes and other parts used in connection with wire ropes must be of good quality, correct size and strength and installed in accordance with the recommendations of the manufacturer. When rope grips (U bolts) are being used on wire ropes they should be installed as per BS EN 16228 which is 4 grips for a 16mm rope which is the minimum size for current Dando models. Details of the fitting instruction are contained in Appendix C of these Guidance Notes.

Winch wire rope should not be looped, knotted or kinked around itself or any other object other than a correctly designed component. Overlaps must be avoided at all times to ensure no damage during winding.

Example of incorrectly laid wire rope

Personnel must be kept at a safe distance from the hoisting, lowering and pulling of wire ropes. The wire ropes should not be straddled or reached across for if a break occurs, serious injuries can result. When hoisting, lowering or pulling the lead driller must be constantly alert at the controls.

Wire rope that has not been used for a period of time should be given a thorough inspection over its entire length before it is put into service again. This inspection should cover all types of deterioration and should be carried out by a competent person whose approval must be given and recorded before further use of the rope.

11.3.1 Wire rope security

Wire rope should wherever possible be unable to become detached from the crown wheel. This is achieved by ensuring that retaining pins and guides are in place prior to erection. These should look similar to those shown below. There should be a minimum of two retainers on the crown wheel one of which shall be V shaped to ensure that the rope is unable to become detached and a single V loop below the wheel on the winch side of the crown wheel to remove whip from the winch side.

Example of wire rope retainers

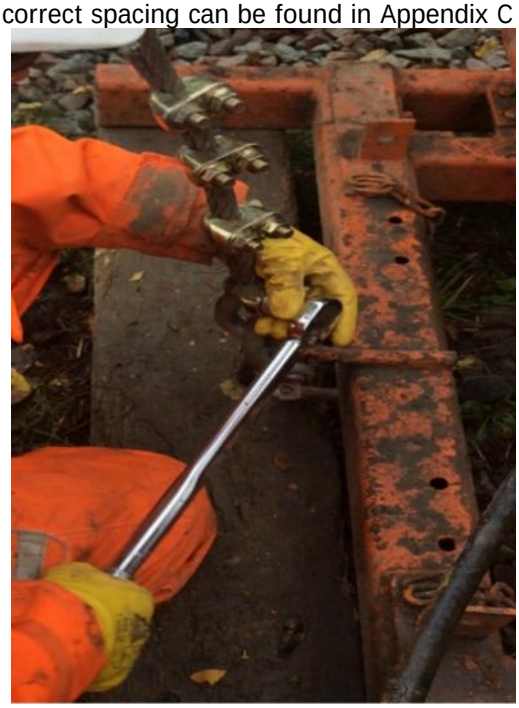
Example of V shaped wire rope retainer

11.3.2 Wire rope termination

The nature of the drilling action causes a high wear on the thimble end of a Cable Percussion wire rope which leads to excessive wear and the need to replace the termination on a regular basis. When the wire rope becomes worn the damaged portion is cut from the remaining rope by means of a specifically designed cutting tool such as shown directly below

Wire rope cutting tool

The wire rope should either be terminated by means of a manufacturer fitted ferrule or by four correct sized BS standard wire rope grips tightened correctly by means of a torque wrench. Details of the correct spacing can be found in Appendix C of these Guidance Notes.



Torque wrench used to tighten U-bolts

U-bolts on wire rope

11.4 Rotating Transmission Parts (PUWER)

In accordance with Regulation 11 of PUWER, all transmission and dangerous moving parts shall be securely guarded. PUWER also takes into account moving parts involved in the working process.

11.5 Winch and Rig Guarding

Every effort must be made to ensure that all exposed rotating components or parts of the cable percussive rig are guarded to prevent accidents to personnel.

The clutch and brake assembly must be guarded by means of a securely attached fully enclosed guard of adequate strength. There shall be suitable maintenance access for lubricating the various mechanisms. This maintenance access must be closed by means of an appropriate cover e.g. a hinged, latched cover.

Example of clutch/brake guarding

The design of the rig means that a completely enclosing guard cannot be fitted since the wire rope has to be manually manipulated. However, the winch must be physically guarded in such a manner that prevents accidental access to it. The design of the guard must not introduce other hazards.

Example of winch guarding

The slip rope drum (capstan) where fitted should never be used in the drilling process. It should be totally enclosed by the manufacturer's supplied guard and never removed.

11.6 Manual and Electric Starting

Manual starting of rig engines is arduous and contains specific hazards, proper training should be given as to the hazards of starting the engine this way before it is carried out to remove the risk of injury. The BDA recommends that electric starting be fitted to any Cable Percussion rigs. Retro-fit kits are available from the manufacturers of both the rigs and the engine.

Do not attempt to start any rig diesel engine unless you have been properly trained. Before attempting to start any engine the operator must be conversant with the use of the engine controls and the correct starting procedures.

11.7 Engine Emergency Stops

The danger zone is the zone within and around the Cable Percussive rig in which a person is exposed to risk of injury or damage to health. For a Cable Percussion rig this means the area in which a person can be reached by operational movement of the drill rig, its working devices, its auxiliary equipment or swinging or falling equipment.

"In order that an actual or impending danger be averted quickly, engine emergency stops shall be provided. They shall stop all relevant movements or functions as quickly as possible to prevent a dangerous situation developing without creating an additional hazard. The emergency stop devices shall be in accordance with EN ISO 13850" (Clause 5.15.4.2 Emergency Stop, BS EN 16228-1).

The emergency stop device shall be easily accessible, placed within comfortable reach of the operator and their function clearly identifiable (see image below).

The emergency stop shall, after actuation, remain engaged until manually reset. This manual resetting shall not start the machine but only permit restarting by the normal starting procedure.

Example of an emergency stop

Every Cable Percussion rig should be fitted with an emergency engine stop and operate as per the clauses above.

It should be noted that with a Cable Percussion rig, even with the engine stopped a potential hazard will still exist in that, if the winch is not braked, the equipment and tools will free fall. In this case, stopping is carried out using the foot brake and clutch as a means of stopping the descending tool.

SECTION 12

TRANSPORT AND TOWING

12.0 General Requirements

Site transport must only be used for the work for which it was designed. It should not be used improperly.

If a vehicle is to be used to carry dangerous substances, it must be fitted with the relevant signs and information. Drivers must be suitably trained and have access to a Dangerous Substances' Advisor. They must also be aware of the limits for carrying dangerous substances. Cable Percussion support vehicles carrying gas bottles should be fitted with the relevant signs.

No person shall ride in or on any vehicle unless there is correct seating provided. Seat belts must be worn at all times when the vehicle is moving on the public highway and should be used at all other times.

When unattended, vehicles should be left securely braked with the engine switched off. The starting key must be removed and doors locked. Keep all valuables out of sight and as far as practicable do not leave valuables, i.e., phones, generators, power packs unattended or in vehicles overnight.

Do not leave vehicle keys in insecure locations in and around site e.g. on desks or visible hooks in unattended site offices.

Drivers should not consume any alcohol, intoxicating liquids or drugs (unless prescribed by a Doctor) during the working day or shift. Staff should advise management and supervisors if prescription medication is being taken. Be aware of the effects of stimulation and energy drinks such as those containing high amounts of caffeine. These can render a person unfit to drive and work and the consequences can be severe.

Vehicles should be checked before being driven on the public highway and any defect in the vehicle must be reported immediately and be rectified before being driven on the highway.

All vehicles used on public roads must be maintained in accordance with the manufacturer's instructions.

12.1 Movement of Drilling Equipment

Vehicles, including trailers, when driven on the public highway, must comply with The Highway Code, Road Traffic Acts, and any other appropriate motor vehicle regulations.

The driver must be in possession of a current driving licence valid for the class of vehicle driven, appropriate insurance, vehicle test certificate, if applicable, and road tax must be in place. When required by regulation, a tachograph must be fitted to the vehicle and used. In general, tachographs must be fitted where the gross plated weight exceeds 3.5 tonnes but the legislation provides compliance criteria and exemptions which are discussed below.

Before travelling on public highways, checks must be made to all vehicles and Cable Percussion rigs for road – worthiness, including being reasonably clean and with special attention to: - lights, indicators, registration plates, brakes, brake lights, and tyre condition. If the rig is to be towed on a public highway it is essential that it complies with the current statutory regulations including tow bar load, weights and dimensions, brakes, lights, number plates and signs. A safety cable to put on the hand brake must be connected, even if not fitted by the manufacturer a safety chain between the two units is strongly advised.

12.2 Operator's License

The Driver and Vehicle Standards Agency (DVSA), previously VOSA, provides advice on operator licensing. DVSA advice is that a dual purpose vehicle and any trailer drawn by it, is identified as being exempt from operator licensing, sometimes referred to as an O License, under existing legislation. Therefore, where a 4x4 is used to tow a trailer or Cable Percussion rig, an operator's license will not be required. Examples of dual purpose vehicles can include 4x4 all-terrain vehicles or even estate cars – vehicles which are constructed or adapted for the carriage of both goods and passengers.

Advice provided by the Freight Transport Association is that in order to satisfy the basic criteria for a dual purpose vehicle it MUST be fitted with 4 wheel drive and have an un-laden weight not exceeding 2040kg.

Examples of vehicles commonly used with Cable Percussion rigs are:

Compliant.

Mitsubishi L200 Double Cab (un-laden weight 1850kg)
Toyota Hilux Single Cab (un-laden weight 1910kg)
Landover Defender LWB Hardtop (un-laden weight 1919kg)

Non-Compliant

Ford Ranger Double Cab (un-laden weight 2091kg)

Companies which operate vehicles above 3.5tonnes gross vehicle weight (gvw) that are used to carry goods on public roads for trade or business purposes should seek further guidance from DVSA or the Freight Transport Association (FTA) to see if an O License is required.

12.3 Tachographs

Tachographs should also be fitted when the combined weight of towing vehicle, trailer and its load is 3.5 tonnes or over and also if the maximum authorised mass of the vehicle and trailer combined totals 3.5 tonnes or over. They are not generally needed if movement is less than 100 km from the designated main base (usually the depot, office or home address). There are some exemptions to the tachograph regulations. It is important that the regulations are checked in detail by organisations and drivers affected by them. Drivers must know the weight and capacity of their vehicle, rig and load.

There are many exemptions but those listed below are the ones which could typically apply to a 4x4 towing a Cable Percussion rig.

(NOTE: ALL four exemption conditions must be met at the same time, otherwise a tachograph will need to be used):

1. The combined weight of the 4x4 and rig is less than 7.5 tonne

2. The driver's main job role is driller and he is driving the vehicle combination to a place to do drilling. (If he were driving the combination to a drilling site for a different driller to use this would not meet the exemption).

3. The driver must use all of the materials/equipment included in the combination for his use alone (tools of the trade) i.e. drilling. (In this instance the driver cannot carry a single item for someone else on his vehicle i.e. carrying work items to site for someone else's use e.g. the engineer or another driller as this would not meet the exemption).

4. The distance travelled to the drilling site is not more than 100kms radius from the driver's registered main place of work i.e. depot/office/home address (if self-employed).

IF all the above points are met a tachograph is not required

12.4 Lighting a Cable Percussion Rig for road towing

The Cable Percussion rigs have an approximate travelling dimensions 8.50m long and 2m wide therefore lights and reflectors should be fitted along the entire length of the rig. Ideally these should show the shape of the drilling rig

Ensuring your trailer/rig has the appropriate lighting is a legal requirement (The Road Vehicles Lighting Regulations 1989). This simple guide will help you to be within the current laws for use on the UK public highway.

All Cable Percussion rigs must have fitted:

- Two red sidelights.
- Two red stoplights.
- Two red reflective triangles.
- An illuminated number plate matching the towing vehicle registration.
- A DVSA compliant number plate (Yellow with Black Lettering)
- Amber indicators (designed to flash between 60-120 times per minute).
- At least one red fog lamp.
- White front reflectors. (mounted on mud guards)
- White front markers/lights.
- Reverse light (those manufactured from 2014 onwards)
- Red/White/Orange side markers. (Either lit or made of a highly reflective material)

It is strongly advised that a long vehicle sign is displayed on the rear of the Cable Percussion rig and an amber flashing beacon fitted to the rear of the rig when driving.

Example of a warning sign for a Cable Percussion rig

12.5 Speed

Speed limits for cars and 4x4s towing caravans or trailers are as follows:

- 30mph limit applies on all roads with street lighting unless signs show otherwise.
- 50mph applies on single carriageways unless signs show otherwise.
- 60mph applies on dual carriageways and motorways

It should be remembered that driving in the right-hand lane of a motorway, with three lanes or more, whilst towing a trailer is not permitted.

12.6 Loads and Carrying Capacity

As Cable Percussion rigs are not specifically designed to carry equipment the brakes, tyres, drawbar and rig frame are fitted only to cope with the nett weight of the rig. Should additional equipment be carried, modifications to the brakes, tyres, drawbar or rig frame may be required to ensure they comply with current towing regulations. Any such modifications would require independent certification after the modifications have been undertaken to confirm compliance.

If light loads are carried the driver should ensure that all loads are correctly positioned (to spread the weight evenly and secured with appropriate fastening systems (e.g. ratchet straps). A nose weight of 52kgs should not be exceeded

Each model of rig will vary and must be checked, as must the safe towing capacity of the towing vehicle. As guidance, the following rig weights are provided in the Table below.

Manufacturer	Rig Model	Rig Weight
Dando Drilling	D150	1700kgs
Dando Drilling	D1500	1500kgs
Dando Drilling	D2000 MK2	1700kgs
Dando Drilling	D2500	1995kgs
Dando Drilling	D3000 MK2	1850kgs
Dando Drilling	D4000	2300kgs
Pilcon	Wayfarer 150	1875kgs
N.B. The above weights include security boxes and in the case of a Dando 2500 and 4000 the electric erection winch as well.		

It is strongly advised that operators of Cable Percussion rigs weigh them prior to using on the road for the first time to ensure that each rig complies with all towing regulations of both the vehicle and trailer.

The driver must be aware of weights in relation to the vehicle that they are driving and towing, in particular the gross weight and the gross train weight. All drivers must make sure that they know where the manufacturers weight plate is located on the vehicle.

Penalties / Fines

Penalties and fines for vehicle overloading are the responsibility of the driver the maximum fine is £5,000

Vehicle Weights, GVW / GTW/ AXLE WEIGHT/ PAYLOAD/KERB WEIGHT

The kerb weight is the weight of the vehicle with all tools and equipment usually carried on board. This will include the driver, any passengers and a full tank of fuel.

Axle weights limit the weight that can be imposed on each axle. Incorrectly loaded vehicles affect weight distribution and break/steering performance. You can be loaded within your payload tolerance but exceed a maximum axle weight.

Gross vehicle weight is the maximum the vehicle can weigh at any time regardless of what is being carried.

When moving on site, the ground conditions should be checked and confirmed as suitable and a check for overhead obstructions should be carried out before moving onto or around the site. Measures must be taken to prevent the vehicle or rig from falling into any excavation, going into water or overrunning the edge of any embankment or earthwork. As far as practical, avoid moving across steep slopes. For units parked on sloping ground ensure the hand brake is on, the vehicle is in gear and wheels on rigs are chocked.

It is vitally important that the axle loading and nose weight is not exceeded at any time. This is particularly important when moving the Cable Percussion drilling rig on site where additional loads are imparted on these components due to the softer ground.

Before reversing, the driver must check to the rear of the vehicle to ensure that there is no danger. Visual and audible reversing warning signals should be fitted where required. A competent person must guide the driver and warn of any danger. Both should have an understanding of the signals to be used. When guiding a vehicle or rig over sloping ground, always stand on the uphill side. The driver is the person responsible for the vehicle at all times.

Vehicles and rigs must be regularly maintained and any dangerous parts repaired immediately along with any mechanical problems.

Where drilling plant has to be loaded on or off other transport, this should be carried out on appropriate ground and in designated areas. It should be loaded on and off by a competent person. Keep all personnel/public clear of the loading zone.

Before moving the rig on to any public highway remove all loose mud and ensure that lights, reflectors and number plates are fitted and are clean. Check that all components of the rig and items of the drilling equipment are secure. Check that the wheel nuts are tight.

Check that tyres are correctly inflated, free from damage and that tread depth meets mandatory requirements. Ensure that tyres are correctly matched and braking systems are in working order. Check that the towing eye is in good condition and not deformed (centre hole should be circular and not oval).

Do not attempt to drag the rig sideways or use a small turning circle as this can severely damage the over-run brake coupling with consequent damage to the braking system.

12.7 Driver Age Restrictions

Drivers must refer to their general driving licence to determine the classes they are allowed to legally drive without further categories being added through passing driver courses.

Aged 17-18 years you can generally drive up to vehicle weights of 3.5 tonnes.
Aged 18-21 years you can generally drive special licensed vehicles, i.e., rigs up to 7.5 tonnes.
Aged 21 years and over you can generally drive specially licensed vehicle, i.e., rotary type rigs over 7.5 tonnes.

Driving Test passed before 1st January 1997

You can generally drive up to a 7.5 tonne vehicle.
You can generally drive up to a 7.5 tonne vehicle with a trailer to a maximum train weight of 8.25 tonnes.

Driving Test passed after 1st January 1997

You can generally drive a vehicle up to 3.5 tonnes.
You can generally drive a vehicle and trailer with a legal train weight of less than 3.5 tonnes with a trailer weighing over 750kg.
You can generally drive a vehicle and trailer with a legal train weight of 4.25 tonnes but with a trailer weight of 750kg or less.

Companies should check the categories on each driver's licence and assess both their competency and temperament prior to driving company vehicles. Where gaps in skills are identified or additional licence categories are required e.g. CAT C (Rigid, Class 2) or CAT B&D (car and trailer) are required of drivers further training should be provided.

SECTION 13

OPERATIONAL SAFETY REQUIREMENTS

13.0 Preconstruction Information and Desk Study

It is of the greatest importance that an accurate site appraisal and desk study is conducted by the client/consultant before any work commences. The results, together with records of any underground and overhead services, contamination, mine workings etc. must be made available to the drilling contractor before mobilisation of the drilling plant. Hazard identification and risk assessments should be made for all areas of the drilling site and works to be carried out. In accordance with CDM, it is the Client's responsibility to provide pre-construction information which should include a Designer's Risk Assessment and include known service information. The drilling contractor may be requested by the Client to obtain such information but should be given sufficient time to make reasonable steps to carry this out.

13.1 Borehole Instructions

Prior to starting work the Lead Driller should be provided with written instructions specifying the requirements for the borehole including planned depth, sampling and in situ testing types and frequency, and any installation required.

It may be found beneficial to include these within a 'borehole pack' which provides all the necessary information about the location including the permits described in Sections 13.3 and 13.4, extracts from service location plans and pre-access photographs showing the condition of the borehole area and accesses prior to work commencing.

13.2 Site Preparation

It is recommended that the site is inspected in advance of the start of works and each borehole inspected by the Lead Driller. Checks should be made to ensure that the route to site is suitable and that the site entrance/exit is in the safest location and is suitable for the equipment to be used. Particular consideration should be given to manoeuvring a very long Cable Percussion rig with a wide turning circle through gateways, off or across busy roads and across level crossings.

All access routes should be investigated and walked by the Lead Driller. Clear access and egress to and from the site should be provided with clear visibility in all directions. If this is not possible, then traffic movement should be controlled. If the Cable Percussion rig is mobilised to site on the back of a low loader or lorry, then it should be loaded or off loaded on firm level ground in a designated area. All plant will be loaded on and off by a competent driver or plant operator or by company personnel appointed and experienced in operating such plant.

Consideration to the provision of site lighting shall be made so that all working areas are well illuminated.

13.3 Permits to Work

Permits to Work are a means of controlling site operations under certain circumstances. These procedures will be carried out when access by drilling personnel to the position has to be carefully controlled for reasons of safety. This may be due to conditions on site, location of site or working processes.

The permit to work should clearly state the precautions to be observed at all times.

Any special operating procedures relative to the work being carried out should be provided in detail.

Examples of possible areas of operation where a permit to work system may be required include work near toxic substances or electrical installations, work in confined spaces, work near cranes, hot work and work with pressurised systems.

13.4 Permit to Dig

A permit to dig system should be in place prior to beginning any excavation. This permit shall outline all of the potential hazards of the Cable Percussion borehole position and ensure that both underground and overhead services have been checked and cleared. Build UK and the Association of Geotechnical and Geoenvironmental Specialists (AGS) have produced guidance on Permit to Dig systems and these are provided below.

The purpose of any permit to dig is to make sure that:

- People are protected from harm
- Underground services are protected
- People methodically follow the correct steps
- Roles and responsibilities are correctly defined and understood
- Contents and restrictions defined in the permit are properly discussed and communicated to all people involved in the excavation activity.

The following people should be either involved in the issue, acceptance, monitoring or working under the control of the permit to dig:

a) The Issuer (a competent service coordinator)
b) The Acceptor (a competent Lead Driller/Supervisor)

The Lead Driller and Support Operative and any other site workers involved in the work also need to be briefed on the hazards, proximity of services and protection requirements and exclusion zones.

It is absolutely critical that the Lead Driller is entirely clear who is responsible for identifying and marking the exact position on the ground where the borehole is to be drilled. Vagueness in defining this and making assumptions is one of the primary reasons why underground services are hit unexpectedly.

A Permit to Dig should normally contain the following,

- Be in duplicate or triplicate formats to ensure that those who need copies have them
- Include the geographical area (Site/Section of works) and borehole numbers to which the permit relates
- Clearly state date and time of issue, review / expiry date
- Confirm who the competent person issuing the permit and the lead drillers are and their designations
- Be issued by a competent person e.g. Appointed Services Coordinator
- Be accepted by a competent person who is responsible for the day to day supervision of the excavation work (Lead Driller)
- Clearly state what methodology is being authorised e.g. breaking of surface, excavation, hand digging and drilling machine type
- Confirm the depth and location of trial holes to be dug
- Confirm that a full cable and pipe avoidance tool and frequency generator (CAT & GENNY) scan has been completed and services identified including visual surveys by a competent person(s).
- Confirm the requirements for re-scanning using the full range of modes of the cable and pipe avoidance tool and frequency generator, e.g. at least every 300mm during excavation works
- Confirm that located services are correctly marked and exclusion zones indicated
- Confirm that all utility and 3rd party (e.g. oil pipelines) drawings are on site and, available in colour (where applicable), within 3 months of date of issue from Owner, clear to read, have any associated cross sections provided and copies are provided to all relevant site personnel to ensure that where shared works are undertaken each team has a copy.
- The permit should be discussed by all people involved in the work activity. Briefings to plant operators and operatives to include control measures to be applied to exposed underground

services. The briefing should provide the opportunity to discuss these controls and arrangements.

- Identify critical high risk services, i.e. Medium, Intermediate and High Pressure gas pipelines, HV & EHV cables, Oil Pipelines, Overhead Cables and the associated safe systems of work
- Risk Assessments and safety Method Statements (RAMS) applicable to work around high risk services (and be attached to the permit)
- Record the calibration dates of the cable and pipe avoidance tool and frequency generator equipment (or other location equipment) to be used
- The permit must be signed by the Lead Driller and Supervisor (a competent services coordinator) and confirm acceptance of the permit controls.

13.5 Underground Services

An adequate procedure for avoiding underground service in accordance with HSE Guidance HSG47, Avoiding Danger from Underground Services, must be in place before any drilling Cable Percussion work commences. A full search must be carried out prior to any intrusive techniques being employed and service drawings must be present on site at all times. Procedures should clearly outline who is responsible for inspecting the service drawings and choosing borehole locations in the office. Prior to any intrusive works being commenced, known services must be positively identified and borehole positions located at a safe distance.

Guidance on the location of underground services can be found in HSG47 and PAS 128 provides a Specification for underground utility detection, verification and location. PAS 128 is a publicly available specification document which allows the utility survey industry to deliver its services to a recognised level of accuracy.

It is well to remember that underground services also include tunnels, underground sewers, high-pressure water pipes and telecommunication cables, gas pipes, electricity cables, oil pipes, chemical pipes etc. Particular care should be taken when working in inner cities with underground railways. It should be noted that service connections from a main service to a building or street light might not be shown on the drawings. It may be prudent to invite representatives from the utility companies to visit the site and confirm the location of any buried services in relation to the proposed drilling position.

The Client or Principal Contractor should also be able to provide information about former use of the site and underground features that may be present e.g. if the site was a former garage where buried fuel tanks may be present.

Before drilling commences, it should be established that it is safe to do so. The location of any buried services in the drilling area should be traced by the use of specialist providers of this service or equipment such as, CAT (cable avoiding tool) and Genny (signal generator), GPR (ground penetrating radar) or other such devices. Services should then be clearly identified and marked. Such locating equipment must be operated and interpreted by a qualified operator. Whilst locating is being carried out, a watch should be kept for signs of other unmarked services i.e. meter or inspection covers, manhole covers, markers, hydrants etc. Lead Drillers should be trained to identify these indicators. It must always be borne in mind that all techniques have their limitations and frequently services and voids can and are missed due to limitations.

A CAT and Genny are a set and both are needed to provide adequate detection capability on site. It should also be noted that a CAT and Genny will not detect plastic pipes unless they were laid with a trace wire.

An inspection pit should always be excavated by hand using safe digging techniques and these inspection pits should be dug as deep as necessary. The pit should be scanned at regular intervals during the excavation and on completion of the pit by a trained competent person. Mechanical breakers may be used for surface concrete or other hard standing but never used within the excavation. If the Client does not wish the excavation of an inspection pit, then the Lead Driller should request this in writing ensuring that they are aware of their responsibilities, however, obtaining this assurance may

not remove liability. Such information should always be considered on the basis of supporting evidence and indications from the borehole locality.

No work should be carried out within 15 metres of any oil or gas pipeline without prior consent from the appropriate pipeline authority. Most service location plans held by utilities were prepared long before modern GPS mapping technology. It is, therefore, not uncommon for utility plans to be very inaccurate or not updated or not updated correctly when more recent work was carried out. Safe digging practice requires a mix of utility plans, survey and trial holes to prove the location of a service.

Ensure that any excavation complies with the requirements for safety in excavations.

If, during the drilling activity, an unexpected service is discovered, the Lead Driller shall stop work and consult the Client/Supervisor. If the borehole is required to be re-located, service drawings should be re-checked and the completed service avoidance procedure followed for the revised locations. The site or the Contractor's emergency procedures must be understood by the drill crew so that the correct action is taken in the event of a utility strike.

13.6 Overhead Services

Before any site work commences, as well as ensuring that the service plans have been checked and include overhead services, the Lead Driller shall always check above locations and along access and egress routes. Overhead services typically comprise either communication lines or electric lines. Damage to overhead communication lines may lead to commercial consequences relating to repair rather than personnel safety whereas damage to overhead electrical would have both safety and commercial consequences.

All practicable steps should be taken to prevent danger to persons from live electric cables or apparatus, preferably by rendering them electrically safe by isolating the service. Precautions to be taken when working in the vicinity of overhead power lines are given in HSE guidance document GS6 (Rev), which should be referred to before starting work. The following information will also assist in reducing the risk.

Cable Percussion rigs or other mobile equipment should not work or be sited within 3 metres (for 11 to 33kV lines) or 7 metres (for the 275 to 400kV lines) of the conductor of a power line or one and a half times the height of the drill rig whichever is the greater distance. The relevant electricity supply authority should be consulted if work is to take place within 15 metres of overhead lines on steel towers, or 9 metres of overhead lines on wood, concrete or steel poles. All distances should be measured at ground level from a position vertically under the outermost conductor. Railway authorities should be contacted for their specific requirements.

Ensure that all necessary warning notices are clearly displayed on site and covered during the Site Induction and any Tool Box Talks on the hazards. Passing must be at designated and correctly constructed and marked crossing places. Safety goalposts may be required at both sides of the crossing place and notices should be displayed indicating the maximum vehicle height at such crossing places.

Drilling rigs, mobile plant or vehicles must not pass under stay wires associated with overhead power lines.

When using platforms or handling long items such as scaffold poles, piping, drill rods, ladders etc. care must be taken to ensure that they are kept at a safe distance from overhead power lines. It must be taken into account that electricity can "arc" across a gap especially in certain weather conditions.

Personnel should not approach or touch any broken or fallen conductors or any plant in contact with an overhead line before conditions are deemed safe by the electricity authority.

Where specific work has to take place beneath overhead electric cables then these cables may need to be isolated and a Permit to Work system operated. Specialist advice must be obtained from the electricity supply authority before work of this nature is carried out.

In certain situations, capacitive or induced AC voltages can be created in fences and pipelines which run parallel to overhead cables which carry a voltage of more than 30 kV. Specialist advice should be obtained from the electricity supply authority before commencing work in these circumstances.

Ensure that all necessary warning notices are clearly displayed on site.

13.7 Unexploded Ordnance/Bombs (UXO/UXB)

During the planning of the investigation consideration must be given to the possibility of intrusive work encountering unexploded bombs or ordnance. Although the likelihood of encountering such materials is usually low the potential consequences can be catastrophic. Although the existence of UXBs is commonly associated with particular urban areas they are by no means restricted to such locations. UXO is typically associated with ex-military establishments such as depots, ranges and armament factories. It is worth remembering that UXB may have penetrated to considerable depth, particularly in soft ground conditions.

If the risk assessment has identified that there is an enhanced risk of encountering UXO/UXB then mitigation measures may be required. These may take the form of a separate process carried out prior to drilling or they may be integrated into the Cable Percussion process where a specialist engineer lower a device which can detect ferrous metal, known as a magnetometer, into the borehole periodically as work proceeds. Because normal steel borehole casing will interfere with the magnetometer's ability to detect it may be necessary for the driller to temporarily pull back borehole casing for a limited distance to allow the instrument to function. Alternatively, the use of special casing made of stainless steel may be required.

If UXO/UXB mitigation measures are required during Cable Percussion drilling the Lead Driller must take instruction from the UXO/UXB specialist as to how to proceed.

13.8 Fire Prevention

Construction sites and drilling sites contain materials that contribute to significant fire risk. This section of these Guidance Notes will assist in reducing the risks associated with these materials and processes. In addition, reference should be made to the HSE Guidance Notes HSG168 Fire Safety in Construction.

All stocks of flammable fuels must be stored in a designated compound clearly sign-posted as a NO SMOKING zone.

Fire risk assessment should be carried out and site personnel instructed what to do if they discover a fire or there is an evacuation. Fire Assembly Points should be arranged on larger sites. An Assembly Point should not be situated where it would obstruct the arrival of the emergency services.

Where fuel storage tanks are required they should be located where they will not add to a fire should one develop. They should be bunded and, whenever possible, not sited on the uphill side of the site or near watercourses. Such fuel tanks must be clearly labelled as to the contents i.e. diesel, petrol, lubricating oil etc.

Petrol should always be stored in approved containers and handled with great care. It must be remembered that it ignites very easily, evaporates quickly and when mixed with air becomes a highly explosive mixture.

Personnel must not smoke or use a naked flame when handling petrol or flammable liquids Petrol must never be used to start a fire, neither should it be used to wash overalls or other items of protective clothing.

Spillages on the outside of tanks or cans during filling operations, must be cleaned away immediately and the cleaning material disposed of correctly.

An approved type of fuel container must always be used to transport small amounts of fuel to and on site. A funnel with an in-built screen must be used to prevent spillage when filling tanks or cans. The tank or can must not be overfilled and some room must be left for possible expansion of the fuel.

The engine of the Cable Percussion rig or any auxiliary equipment must be stopped and allowed to cool before refuelling, or topping up of the lubricating oil.

Any fuel or oil leaks on the Cable Percussion rig or auxiliary equipment must be repaired as soon as they are observed.

In cold conditions, never use naked flames to warm engines or assist starting. Use only approved cold starting methods.

Do not run fuels or oils into the borehole to loosen stuck equipment.

Containers that have been used for carrying or storing flammable products, and which may contain residues of such products, must be disposed of safely.

It may be that drilling has to be carried out through formations that may contain flammable gas. In such cases, special precautions must be put into place to ensure that risk from fire or explosion is controlled. These special instructions are contained in Section 5 of the BDA Health and Safety Manual.

Oil or diesel contaminated clothing constitutes a fire and health risk and must be changed immediately. Oily rags and similar materials also constitute a fire risk and must not be left lying around the drill rig or site.

Ensure that temporary site accommodation and buildings are correctly positioned are of the correct fire resistant construction and have appropriate fire precautions installed. Such site accommodation must be kept clean and tidy and should not contain greasy clothing, rags, paper or similar as such material could be the combustible materials needed to start and prolong a fire.

An adequate number of correctly sized and the appropriate type of fire extinguishers must be made available on site and maintained. A competent person shall inspect each at regular intervals. The results of such examinations must be entered in a log book kept for the purpose and the equipment suitably tagged. After use they must be replaced or refilled as appropriate. In the case of Cable Percussion rig as diesel is used the minimum size of fire extinguisher is a 2Kg dry powder

It is important that personnel who have not been trained in the proper use of firefighting equipment do not put themselves at risk by fighting a fire. Only personnel on the site who are trained in the use of portable firefighting equipment should consider tackling any fire.

13.9 Working at Height

Wherever possible working at height on a Cable Percussion rig must be eliminated. Careful planning and good maintenance of the drilling rig will hugely reduce the need to work at height. Simple precautions prior to set up are outlined in Section 5 of these Guidance Notes. The fitting of the electric raising winch to lower the damaged or worn part to the floor to carryout repairs should always be considered. The climbing of a Cable Percussion rig can be very dangerous and should always be a last resort. If it becomes necessary to work at height, then wherever possible mechanical means such as a mobile elevating work platform MEWP (cherry picker) should be used.

If it is deemed necessary to climb the rig, the climber must wear a safety harness and be clipped on at all times. The use of a safety harness when personnel are working at height particularly when undertaking simple maintenance to the mast and sheave wheel assembly is mandatory. Persons using safety harnesses shall be both trained and competent. Before using any safety harnesses or planning

any working at height a robust risk assessment and method statement must be in place. These must include an appropriate rescue plan of how any injured party suspended in the mast by means of the harness will be recovered safely.

Safety harnesses should be inspected in accordance with the requirements set out in BS EN 365. Energy absorbing lanyards should not be used due to the significant extension they allow. The falling person could hit the ground before the energy absorbing lanyards work as designed. A non-energy absorbing lanyard can be fitted to a belt with two D rings and wrapped around the top support rung of the rig when repair or maintenance work is required at the top of the mast. The length of the non-energy absorbing lanyard should of a suitable length such that it only requires to loop through the cross member once with as little slack as possible thereby preventing anything but the smallest fall.

SECTION 14

ENVIRONMENTAL CONSIDERATIONS

14.0 Site Categorisation

This guidance summarises the significant environmental considerations which apply to Cable Percussion drilling but more detailed guidance can be found in the BDA Guidance for Safe Intrusive Activities on Contaminated and Potentially Contaminated Land and Guidance on Managing the Risk of Hazardous Gases when Drilling or Piling Near Coal.

In order to control some of the environmental considerations and to provide a readily understandable guidance in respect of the potential hazards the BDA developed a site 'colour' coding categorisation system. The colour coding comprises GREEN, YELLOW and RED which broadly relate to low, medium and high risk to individuals but more detail of the categorisation is provided in the table below.

SITE CATEGORISATION SYSTEM

BDA SITE DESIGNATION	BROAD DESCRIPTION
GREEN	Substances that have little potential to cause significant permanent harm to humans. Examples would be uncontaminated natural materials including topsoil, hardcore, bricks, stone, concrete, excavated road materials, glass, ceramics, abrasives, wood, paper, fabrics, cardboard, plastics, metal components, wool, cork, ash, clinker, etc. provided that these do not contain other substances that could be significantly harmful to humans. Note that topsoil and sub-soil may be contaminated and that there is a possibility of bonded asbestos being present in otherwise inert areas. In these cases a YELLOW Category applies.
YELLOW	Substances that are not sufficiently harmful to potentially cause death, injury or impairment of health but nevertheless require protection to be worn to ensure that any health issues do not arise. Examples would be waste food, vegetable matter, household and garden waste, leather, tyres, rubber, latex, electrical goods and fittings, non-toxic metals, bitumen, fuel ash and solidified wastes. Where there is potential for significant volumes of ground gas at concentrations that are toxic, flammable or could cause explosion, then a RED Category should be used.
RED	Substances that could subject persons to risk of death, injury or impairment of health. Examples would be any substances that are corrosive, acidic, carcinogenic, cause skin irritation or respiratory problems, affect the nervous system, affect the organs, etc. See above in respect of ground gas.

NOTES

1 A Greenfield Site would normally be included in the GREEN Category unless there is evidence to indicate a YELLOW Category

2 Indiscriminate dumping (or in the case of older sites, uncontrolled/unlicensed landfilling) may have taken place on a site and this should be taken into consideration when determining the appropriate category.

3 Landfill sites or other sites where significant deposits of bound or unbound asbestos occur should have a RED designation. However, other sites may have only very small quantities of asbestos, often present as asbestos cement, which whilst presenting a hazard may not on its own warrant the highest level of protection. In these cases it may be sufficient to simply add water to the borehole or other form of intrusive activities to prevent asbestos fibres becoming airborne and hence available for inhalation and to wear disposable masks suitable for low levels of asbestos.

4 The presence of radioactive materials on a site is not included in the above guidance and appropriate references on this should be consulted including regulations.

5 A Desk Study and a Risk Assessment must be carried out before the site is categorised (see Section 5.0). As part of the desk study, a site walk over must be undertaken. This should look at both the site and the land usage surrounding the site.

14.1 Disposal of Waste, Excess Arisings & Other Materials

The disposal of excess arisings on the worksite should be avoided and waste skips should be available to contain spoil and any other waste being generated during the Cable Percussion drilling process.

Equipment and consumable items purchased, transported and stored on a site are not considered waste if used for the purpose for which they were purchased or supplied. However, if these materials are discarded or left on site after the works have been completed then they shall be considered as waste and shall therefore be subject to the provisions contained within the waste legislation.

The production, transportation and storage of samples for subsequent geotechnical or chemical testing would not constitute a waste.

However, once testing is complete the tested material and any excess material not tested is considered to be waste and therefore subject to the provisions contained within the waste legislation.

The classification and disposal of waste material is controlled by a number of UK Regulations and European Directives. The Environment Agency has provided guidance on how the legislation applies to contaminated soils in the Framework for the Classification of Contaminated Soils as Hazardous Waste.

For disposal at landfill, waste material is categorised as suitable for disposal in inert, non-hazardous or hazardous landfills depending on the source of the waste and, in most cases, on the concentrations of potentially hazardous chemicals within it. There is a fourth category which is stable non-reactive hazardous. This fourth category mostly comprises asbestos-containing waste and blocks of stabilised waste. Wastes such as liquid waste, explosive or highly oxidising or flammable materials and tyres cannot be accepted at landfills.

The person who is in overall control of the investigation or other form of intrusive works that produces samples must ensure that a contamination hazard assessment is carried out prior to the works.

It is the responsibility of the Cable Percussion Lead Driller to inform the Supervisor if material of concern or potentially contaminated material is encountered, to label the samples appropriately and give appropriate instruction for those who may deal with the samples such as the Logging Engineer and Laboratory Staff.

Waste which includes paper, wood, organic material or plastics is not inert waste. Whilst soil and stones from uncontaminated sites are accepted as inert waste without test, i.e. contamination is not reasonably expected to be present, soil and stones from contaminated or potentially contaminated sites have to be tested before classification.

14.2 Transporting Waste

Waste transfer can only be carried out by carriers licensed under the Waste Management Regulations and must be done either under Duty of Care Waste Transfer Notes for inert and non-hazardous waste or under Waste Consignment Notes for hazardous waste.

Copies of the waste transfer notes and consignment notes must be retained at the premises or on site for inspection by the Environment Agency. Records should be properly maintained by a competent person who is designated with this responsibility.

14.3 Preventing Cross Contamination

Care must be taken to ensure that contamination is not spread between sites, particular work activities, individual locations or stratigraphic horizons.

The Cable Percussion rig and equipment should be adequately cleaned between boreholes and between sites to avoid cross contamination. This will not only avoid compromising the technical information for any work, but it will prevent the spread of contaminated material during plant transport and minimise the potential to contaminate 'clean' ground, groundwater or the environment.

Cleaning should be undertaken wherever possible using steam, hot water or high pressure systems. It should be undertaken between work site locations and where circumstances dictate, such as in a contaminated land site investigation, between exploratory hole locations, between contaminated and un-contaminated ground and between samples as necessary or specified.

Cleaning operations should be undertaken either at a central location or at the work site. Effective controls should be in place to handle waste fluids and solids. These may include the use of bunded areas lined with plastic sheeting. Wash fluids should be contained and then stored in suitable containers, prior to the issue of chemical laboratory test results as these may indicate that the wash fluids will require licensed disposal by a waste disposal specialist.

Consideration must be given to the hazards of close contact with water-borne contaminants generated during the cleaning process and appropriate additional PPE should be provided to and worn by site staff. The volume of water generated during the cleaning process should be minimised wherever possible.

14.4 Prevention of Contamination by Plant and Materials

Works should be planned and executed in such a way as to minimise the risk of impact upon the environment by the uncontrolled release of materials used during the site operations.
Materials storage should prevent release into the wider environment of substances such as cement, bentonite and fuel oil. For significant quantities of fuel oil, storage should be within double-skinned bowsers or similar and/or within lined, bunded areas

Plant must be well maintained to prevent leaks of engine and hydraulic oil and drip trays should be used as a precaution. Refuelling procedures should where possible be carried out away from the proximity of water courses.

Suitable spill kits should be available at the borehole location ready for immediate deployment.

14.5 Prevention of Contamination by Arisings

Cable Percussion drilling can by its very nature bring significant quantities of hazardous contaminants to the surface. Any 'clean' arisings should be stockpiled separately and if necessary used as the near surface reinstatement of any exploratory hole. The use of polythene sheeting and plywood boards as a temporary measure during site operations can help ensure that there is no contaminated material left at the surface on completion of the works.

Potentially contaminated groundwater and leachates should be contained within a controlled area, again using polythene sheeting and sandbags to prevent seepage into otherwise clean ground. It is important to prevent the spread of contaminated water and arisings into bodies of surface water, including drainage ditches.

14.6 Limiting the Creation of Contamination Pathways

A migration pathway is a physical link between contaminated and uncontaminated ground / groundwater. It is essential that consideration is given to the construction design for any temporary or permanent works so that the creation of migration pathways is avoided. Should contaminants be encountered that cannot be controlled during any intrusive activities, then work should cease until a revised safe method of work is established.

An aquifer protection system can be specified and deployed during the construction of boreholes to prevent the introduction of contaminated soil and / or groundwater into uncontaminated ground and / or groundwater.

After placing a seal in a borehole within casing, usually at the base of any made ground or perched groundwater unit or at an impermeable horizon above/below an aquifer, the hole is advanced at a smaller diameter using clean tools and casing. The seal will generally consist of bentonite slurry, which creates an impermeable layer between the two strings of casing, through which contaminants cannot pass.

The design of aquifer protection measures must be agreed at the time of tender, so that the extra time and cost involved in deploying such techniques can be allowed for. The specific design will depend upon the particular ground or ground water regime expected and revised if necessary based upon the preliminary site results.

Any groundwater, leachate or gas sampling / monitoring / venting installations should be designed and constructed to avoid creation of a migration pathway. The response zone of a particular installation should not 'bridge' between contaminated and uncontaminated horizons. A migration pathway can be broken by the following:

- installation of a permanent plastic or steel casing to 'seal' contaminated horizons from uncontaminated ground;
- ensuring that the granular response zone does not extend over the boundary between contaminated and uncontaminated ground;
- use of hydrated bentonite pellets or similar impermeable material to form a seal above and if necessary below response zones;
- ensuring that all annular cavities are fully sealed. Any cavities could create a migration pathway;

Appropriate materials should be selected for any monitoring installations so that they are suitable for the depth of installation and the expected chemical contamination in the ground. For example, stainless steel is unsuitable in low pH environments and organic compounds such as chlorinated hydrocarbons, anilines, ketones and nitro benzenes cause PVC to swell and eventually to dissolve. However, PVC is essentially impermeable to alcohols, aliphatic hydrocarbons and organic acids.

Installation materials should be new and/or certified clean.

14.7 Control of Gas Emissions

A range of gases can pose a hazard to the health and safety of operatives, site personnel and the public during construction activities on contaminated sites. Potentially harmful gases, but not necessarily all potentially harmful gases are detailed below:

Oxygen deficiency occurs in the atmosphere when the oxygen concentration is less than 19% by volume. This can result from the presence of other gases, oxidation of metals, burning, or by chemical reaction with certain soil types such as glauconitic sands.

Oxygen enrichment has the potential to significantly increase the risk of underground fire, e.g. in a landfill or coal measures, or above ground in respect of equipment and materials.

Methane can be generated naturally from Coal Measures strata, biologically from the decay of organic material, peat and waste, or can originate from man-made sources i.e. landfill. Methane is explosive in air at concentrations of between approximately 5 and 15% by volume (in reality the range can be as much as 4.4 to 16.5%). The level of 5% is referred to as the lower explosive limit (LEL) and 15% is referred to as the upper explosive limit (UEL). It should be noted that methane at concentrations above 15% by volume is also dangerous because there is always the potential for dilution to bring the concentration down to within the explosive range. At levels above 33% by volume in air, methane is also an asphyxiator due to the displacement of oxygen.

Carbon monoxide is highly toxic. It may be encountered anywhere where fossil fuels are being burnt, notably in vehicles and plant exhausts. The possibility of the presence or creation of carbon monoxide should be borne in mind whenever intrusive methods are being used in coal measures.

Carbon dioxide can be encountered in vehicle exhausts and naturally from the chemical reaction of groundwater in carbonate soils. It is also generated by the biodegradation of landfill wastes and from organic materials in fills. It is found in Coal Measures strata and peat deposits. At high concentrations, carbon dioxide is an asphyxiator.

Hydrogen sulphide is a highly toxic gas, often associated with sewers, ‘swamp gas’ and naturally in Coal Measures strata. The ability of humans to recognise the ‘rotten egg’ odour reduces with exposure, thus increasing the risk to human health.

Diesel engine emissions can contain a range of toxic and or carcinogenic compounds and also particulates.

Volatile organic compounds such as toluene, xylene and benzene are thought to be carcinogenic and can be highly explosive at concentrations of approximately 1% by volume in air.

Hydrocarbon gases generated by the volatile elements of petrol, diesel and/or oil are flammable at between 1 and 7 or 8% by volume in air. Obviously higher concentrations can dilute to these values.

Where there is a possible risk of gaseous emissions, the site rules should include regular or constant monitoring during intrusive operations. Petrol driven plant should not be used where explosive gases are expected or possible. Plant should be fitted with spark arrestors and/or Chalwyn Valves as appropriate.

Where necessary intrinsically safe gas monitors or ‘explosimeters’ fitted with alarms should be used to monitor an operative’s exposure to hazardous gas conditions at the work site. The gas monitor should be equipped as a minimum with alarms to record elevated levels of carbon dioxide, hydrogen sulphide and explosive gases together with decreased levels of oxygen. There are three main types of gas monitor:

- Electronic atmospheric monitoring or gas detection equipment
- Detector tube
- Flame safety lamp

The site rules should include training in the use of such equipment and the procedures to be adopted in the event of a gas release.

Any electronic monitoring equipment on the site should comply with BS EN50104, Electrical apparatus for the detection and measurement of oxygen and/or BS EN's 50054, 50055 and 50056 for methane.

Monitoring should be undertaken prior to an operative being exposed to any potential gas hazard. Gas levels should also be recorded at regular intervals throughout a shift or immediately any gas is encountered or is suspected to have been encountered.

Reference should be made to the current short and long term exposure limits defined by the Health and Safety Executive.

Where a work site is defined as a confined space, personnel should be trained in the use of the appropriate respiratory protective equipment (RPE). Confined space work is outside the scope of this publication and reference should be made to the 'Safe Work in Confined Space Approved Code of Practice, Regulations and Guidance' issued by the Health and Safety Executive.

Where gas is expected, work sites should be organised such that gases are blown away from the work area if possible. Forced ventilation can be used where necessary.

The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) apply to environments that could potentially have explosive atmospheres. DSEAR sets out requirements for risk assessment, the elimination or reduction of risk, area classification, training, etc.

SECTION 15

PERSONAL HEALTH AND SAFETY

15.0 Personal Protective Equipment (PPE)

All personnel must be protected from any significant and reasonably foreseeable hazard likely to be encountered whilst carrying out any work on the drilling site. Protective clothing, footwear and other equipment must therefore be made available to all, maintained in good order and replaced when necessary. This equipment must be supplied free of charge by the employer to all company personnel. Such protective equipment and its application must be in conformance with the requirements of the Personal Protective Equipment at Work Regulations. Guidance as to the application of these regulations may be found in HSE Guidance Notes L25. There should be a written procedure for the routine issue of PPE. This should also include a statement with regard to the arrangements for sub-contractors.

It should be clear that PPE is a last line of defence and cannot be used to substitute engineering controls.

Standard PPE requirements for a Cable Percussion rig are as follows

Mandatory

Hard Hat
Safety boots
Overalls
Gloves
Ear protection

Risk assessment and/or Client dependant

High visibility clothing
Safety eye wear
Disposable overalls
Fitted face pieces/masks or powered breathing hoods

All personnel involved in drilling activity must wear close fitting overalls. It is recommended that High Visibility overalls or vests are worn over the overalls. Such clothing should be kept clean by frequent washing, and a clean change of clothing for each crew member should be available on site at all times. The use of clothing with draw strings and the use of scarves, ties etc. should be discouraged as they

may become entangled with rotating or moving parts. For the same reason, personnel with long hair should consider wearing a hair net in conjunction with their safety helmet.

Safety helmets must be worn at all times by members of the drill crew and visitors to the site. These items must be regularly checked for damage. Safety helmets should be replaced when damaged. Prior to each shift, safety helmets should be inspected for damage to the shell and deterioration of the inner harness. Typically, safety helmets should be replaced after two years of use or in accordance with manufacturer's guidance.

When working on, or adjacent to the public highway or rail tracks, high visibility clothing with fluorescent markings to the correct standard for the road type, must be worn at all times. On rail tracks they must be, of a colour and type to the approval of the operating rail authority.

Gloves should be worn. Note that a wide variety of gloves are available. The correct gloves need to be selected to reduce risks from the hazards identified and to be of the correct size.

Rig personnel must never wear jewellery of any kind while taking part in drilling activity.

Eye protection is very important. Any eye injury, no matter how slight, should receive prompt medical attention. Even a slight eye injury may lead to serious complications.

The correct type of eye protection must be provided, worn and should be maintained in good condition by all drilling personnel. Personnel must wear approved safety glasses where a risk has been identified.

Splash-proof chemical goggles or face-shields must be used when handling potentially hazardous or injurious chemical liquids, powders or vapours, such as cement, chemicals, chemical cleaning solutions, creosoted material, asphalt or bitumastic compounds. Personnel working near such operations should also wear goggles.

Where negative pressure Respiratory Protective Equipment (RPE) is used, personnel must undergo face fitting to ensure protection. Face hair (stubble) will have a detrimental effect on the efficiency of such RPE and may require the provision of forced air respirators such as air fed respirators.

Eye protection affording complete coverage must be worn when dust hazards exist or when using compressed air or steam to clean machinery or equipment. To ensure maximum protection and comfort, eye protection equipment used must be properly adjusted to the individual's face. Rubber gloves, a rubber apron and chemical goggles must be worn when hazardous bulk chemicals or materials are to be handled. Any exposed skin must be liberally treated with a suitable barrier cream.

When excessive fogging of lenses of goggles or glasses occurs, various types of antifogging compounds are available for application to the lenses to limit fogging condition and there are glasses which are designated as anti-fogging.

There must be readily available an adequate supply of sterile saline eyewash for cleaning eyes should they become contaminated (see below).

When welding activity is being carried out, protective shields should surround the area. Special goggles to protect against the harmful light must be worn by anyone who must work in the proximity of the welding operations.

In order to meet the requirements of the Noise at Work Regulations, adequate hearing protection must be provided and be worn by all personnel (see Section 16).

All site visitors must wear safety boots with steel toecaps and a reinforced midsole, Hi-Viz overalls or vests, and safety helmets while on site. Trainers, shoes, boots and ordinary wellingtons do not provide sufficient protection. Rigger boots are not recommended as they do not provide adequate ankle support.

15.1 First Aid

It is recommended that as Cable Percussion drilling is high risk, Lead Drillers should attend a 1 day Emergency First Aid at Work course. It is recommended that all Support Operatives also hold the same certificate.

Certain sites require a qualified First Aider. A qualified first aider is a person who holds a certificate of competence in first aid at work issued by a body approved by the HSE. The certificate is obtained after passing a three day First Aid at Work training course. It is recommended that should the Lead Driller or Support Operative be a designated First Aider, they should attend a 3 day Emergency First Aid at Work course.

Where first aiders are required, they must be available at all times when work activity is being carried out. Foreseeable absences, holidays and shift work must be taken into consideration and the appropriate cover instituted.

Where the assessment of first aid requirements identifies that a first aider is not necessary, the employer must appoint a person to take charge of the first aid arrangements, including looking after the first aid equipment and communicating with the emergency services if necessary.

Provision of first aid on any drilling site or work place is a legal requirement. Assistance as to how these regulations are applied may be obtained from information and guidance contained in the HSE Guidance L74 First Aid at Work. In addition, injuries, diseases and dangerous occurrences must be reported to the appropriate person or authority in accordance with the requirements of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations. Guidance on these regulations is available from the HSE website.

Personnel must be provided with details of the location of the nearest A&E hospital department during the Site Inductions and these should also be posted on the site office notice board.

First aid boxes must be supplied, readily available and maintained, one to each Cable Percussion drilling rig on the site. All first-aid containers must be identified by a white cross on a green background and be placed in charge of a responsible person(s) who shall be readily available.

There is no mandatory list of items that should be included in a first-aid container and this will depend upon the level of risk of the site activities and nature of the site as determined in the risk assessments. The suggested contents of a site first aid box are shown in the following table.

Suggested First Aid Items
➢ Leaflet giving general guidance on first-aid ➢ 20 individually wrapped sterile adhesive dressings (assorted sizes) ➢ 2 sterile eye pads ➢ 4 individually wrapped triangular bandages (preferably sterile) ➢ 6 safety pins ➢ 6 medium sized individually wrapped sterile un-medicated wound dressings - approximately 12 cm x 12 cm ➢ 2 large sterile individually wrapped un-medicated wound dressings - approximately 18 cm x 18 cm ➢ 1 pair of disposable gloves (non-latex) ➢ 1 Litre of sterile saline eyewash

As many drilling sites will be some distance from a supply of clean running water, eyewash solutions should be added to first aid kits. All first aid items and especially liquids and creams have a limited shelf life that is further reduced if they are kept in a warm or hot environment – such as a car boot in the summer.

SECTION 16

OCCUPATIONAL HEALTH

16.0 Occupational Health

It is a requirement of The Health and Safety at Work Act that every employer considers the health of their employees to ensure that the proposed work does not in any way damage or compromise their health. Poor control of occupational health accounts for almost two thirds of lost time from work and is commonly overlooked.

Occupational health relates to how work and the work environment can affect an employee's health and equally how an employee's health can affect their ability to do their job.

Occupational health is generally more difficult to manage than safety. The causes and consequences of poor safety at work are immediate and often relatively easy to deal with. Work-related causes of ill health however, can be more difficult to spot. It can often take some time for symptoms to develop so the connection between cause and effect is less obvious, but once the problems have been recognised and acknowledged, solutions are now well documented.

For the most common occupational health problems, such as back injuries, there may be other causes or contributing factors (e.g. lifestyle) that have nothing to do with work. Workers may be unwilling to admit themselves that they have work-related health problems because of fears about their job security or the stigma attached to certain types of illness.

16.1 Areas for Consideration

The construction industry, of which the drilling industry is part of, is a high risk industry with a high percentage of fatal and major injuries but what is less recognised is that construction is a high-risk industry for health issues too. Most common health issues which the industry needs to be aware of are:

- Musculoskeletal Disorders (MSDs): mainly comprising work-related upper limb disorders (WRULDs) and back injuries;
- Hand Arm Vibration Syndrome (HAVS): caused by usage of vibrating equipment;
- Work-related Stress: which can be caused by poor work organisation;
- Skin Cancers: caused by excessive exposure to sunlight whilst on site;
- Occupational Dermatitis: from handling cement, fuels, bentonite etc.;
- Noise-induced Hearing Loss: where noise levels exceed 85 dB(A);
- Asbestos, dust containing silica and diesel fumes which are the three largest causes of cancers amongst construction workers.

This section provides guidance on the health issues most applicable during Cable Percussion drilling and additional industry guidance has been produced by the Association of Geotechnical and Geoenvironmental Specialists (AGS) guidance and can be found on their website www.ags.org.uk.

16.2 Health Surveillance

It is a requirement of the Management of Health and Safety at Work Regulations, that where the employer identifies a level of residual risk to health, where symptoms could be detected by recognised methods, they shall enroll all affected employees in a suitable programme of health surveillance.

Health surveillance should be carried out by a specialist occupational health nurse and repeated annually.

For Cable Percussion drillers, surveillance should definitely include hearing assessments, but dependent on the results of risk assessments they may also need hand arm vibration assessments, spirometry (breath function) and general fitness for work.

16.3 Noise

The typical Cable Percussion drilling rig generates significant quantities of noise as a result of the engine and percussion activities. Noise levels experienced throughout the day will vary depending on the nature of the ground, surrounding structures and the type of tasks being carried out.
Typical noise levels when measured at the Support Operative position are as follows:

- Engine noise typically runs at around 80 to 82 dB(A)
- Peak noises may be louder and typical may reach 100 dB(C)

For the Lead Driller, engine noise is generally louder and percussion noises are typically the same as that experienced by the Support Operative.

Under the Control of Noise at Work Regulations, the employer has to establish the levels of noise to which employees are exposed and take measures to reduce exposure. Maximum limits are applied to daily and weekly noise dose levels and peak exposures and where these are likely to be exceeded, despite controls, hearing protection zones must be established as follows:

1st action level: Employer must provide ear defenders but wearing them is optional

- Noise dose (8 hour or one week) - 80 dB(A) $L_{ep,d}$
- Peak exposure - 135 dB(C)

2nd action level: The wearing of ear defenders is compulsory

- Noise dose (8 hour or one week) – 85 dB(A) $L_{ep,d}$
- Peak exposure - 137 dB(C)

Taking noise samples and making assessments can be very complicated and must be done by specialists. Typically, all lead and assistant drillers will exceed the 2nd action level and therefore wearing of ear defenders will be compulsory when the noise is present.

Controls
In addition to the establishment and enforcement of hearing protection zones, the employer must consider how control can be achieved in other ways such as:

- Fitting silencers to engine exhausts and keeping both rig and engine well maintained.
- Turning engines off when not in use
- Limiting employee time in the noisy environment

Hearing protection
Over ear muff type hearing protection to the following standards is arguably the best choice as their noise attenuation properties are more reliable and they are simpler to wear.

- BS EN 352-1. Hearing protectors. Safety requirements and testing. Ear-muffs.
- BS EN 352-3. Hearing protectors. Safety requirements and testing. Ear-muffs attached to an industrial safety helmet.
- BS EN 352-4. Hearing protectors. Safety requirements and testing. Level-dependent ear-muffs.

Ear plugs are also available but care must be taken to ensure that a) they are inserted properly to achieve the optimum level of noise attenuation and b) a high degree of cleanliness is maintained to avoid ear infections.

The level of protection required will depend on the nature of the work, the results of assessment and duration of works. Typically, around 15dB attenuation needs to be achieved. Over protection can lead to safety issues due to an inability to communicate on site.

16.4 Vibration

Employers have a duty to identify and control the risk of exposure to hand arm vibration to employees. Vibration risk assessment should be undertaken for the use of the Cable Percussion rigs, including the clutch/brake handles and any other percussive hand tools e.g. road breakers and jack hammers.

Data is available for the majority of such equipment and includes Exposure Action Values (EAV) which indicate the daily level when control measures are required and Exposure Limit Values (ELV) which indicate maximum daily levels.

- a daily EAV of 2.5 m/s A(8) - that represents a clear risk requiring management; and
- a daily ELV of 5 m/s A(8)- that represents a high risk above which employees should not be exposed.

Quantifying the level of risk can be very complex but the HSE provide guidance that simplifies the process. The first stage is to determine the vibration magnitude of the equipment. These values should then be cross referenced with exposure time using the HAV calculator on the HSE website:

http://www.hse.gov.uk/vibration/hav/vibrationcalc.htm

Where the EAV is likely to be exceeded, actions should be taken to reduce the exposure to a level as low as reasonably practicable through actions in the following hierarchy:

1. Implement other working methods to eliminate or reduce exposure
2. Choose alternative equipment with lower vibration characteristics
3. Maintain equipment appropriately
4. Train employees to use equipment in a manner to reduce risk
5. Limit duration of work
6. Adjust work periods
7. Provide clothing to keep employees warm and dry

16.5 Control of Substances Hazardous to Health (COSHH)

The Control of Substances Hazardous to Health Regulations (COSHH) generally requires that, whether you are an employer, contractor, subcontractor or self-employed, you protect persons who may be exposed to health risks arising from hazardous substances that may be found in the workplace.

A summary of COSHH requirements is listed below: -

- Assess risks to health from hazardous substances from the work activity and determine the action required
- Eliminate the material or substance for material of lower risk
- Implement a prevention or control programme
- Maintain and monitor those programmes
- Provide health surveillance where appropriate
- Inform, instruct and train employees in regard to work with hazardous substances
- Maintain records where required

Materials used in the construction of works or materials encountered, as part of the drilling process, may be hazards to health. These materials may be used directly in the construction process e.g. grouts, soil modifiers or conditioners which may be part of the drilling process, or materials present in the medium being drilled e.g. silica in concrete or rock. Hazards may also arise from toxic ground contaminants.

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

Many hazardous materials have workplace exposure limits (WEL) where inhalation risks exist. These limits are given in HSE guidance document EH40 that are given either an Occupational Exposure Limit (OEL) or Maximum Exposure Limits (MEL). The WEL comprises a long term (8 hr shift) and a short term (10 min) exposure limit.

When a substance labelled as hazardous is procured, a safety data sheet should be requested. The safety data sheet should provide the user with details of the materials and hazards associated with them together with general advice on controls. The control measures are often limited to the level of personal protective equipment that is required to control the risk. It is the supplier's responsibility to ensure that the information on the Safety Data Sheet is accurate. If the material is supplied onwards, after being used in a newly manufactured material, the supplier of the new material inherits the responsibility. Guidance regarding the law covering preparation and supply of safety data sheets is contained in the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) Regulations.

16.5.1 COSHH Risk Assessment and Control

A COSHH risk assessment needs to be carried out for all work activities where material health hazards are identified. The risk assessment needs to identify health hazards as well as the more commonly recognised safety hazards. These need to include all operations in which personnel may be exposed to the material. As part of the risk assessment it is necessary to identify the materials that present the hazard. The manufacturer or supplier of the equipment will be able to identify these materials. The risk must then be assessed and appropriate measures put into place to control the risk.

The risk control strategy should adopt the following hierarchy of measures to control the risk:

- Avoid the risk – eliminate the material or substance for material of lower risk
- Evaluate risks which cannot be avoided
- Combat risks at source
- Provide safe systems of work, personal protective equipment (PPE), information and training to minimise risks

It should be noted that designers have duties under The Construction (Design and Management) Regulations to control risks as part of the design process. Designers of schemes should therefore be aware of any health and safety issues relating to the materials they specify directly or indirectly.

16.5.2 COSHH - Materials used in the Drilling Process

Attention is drawn to the following materials that are commonly used in the drilling operation, in maintenance of drill rigs and ancillary equipment that may cause a health risk to personnel if swallowed, skin or facial contact is allowed. This list is not exhaustive but COSHH assessments should be carried regarding all materials used and the relevant Safety Data sheets made available to personnel concerned and appropriate controls put in place.

Fuel – petrol and diesel*	Coolants and anti-freeze agents
Battery acid	Corrosion inhibitors
Lubricating oils and greases	Hydraulic fluids
Cement and Bentonite	Bleach and hand cleaners
Paint	Aerosols

*Diesel exhaust contains particulates and nitrogen oxides which are both harmful to health and exposure must be reduced to as low a level as possible.

The following points should be observed and will assist in reducing risk to personnel and others.

- The user of any hazardous substance should be aware of the potential risk associated with that product and the correct manner in which it should be used.
- All available information should be obtained from the supplier of the material or substances and special precautions relating to specific products given in specific written assessments
- Do not use or store hazardous materials in areas where food is prepared or consumed
- Facilities for the washing and cleansing of the skin must be available together with the necessary cleansers and barrier creams
- Clean all spillages immediately and dispose of the waste in the correct and safe manner
- Ensure that only authorised personnel handle hazardous materials and that the correct equipment for handling the product is available
- If any person handling the materials shows the symptoms that may have been caused by exposure to hazardous products, they should be removed from the area and medical advice should be obtained without delay
- Measures must be taken to keep others, members of the public and especially children, away from areas where harmful substances are present or being used
- Care must be taken when using materials that are in powder form. Due to the fine texture of powder, eye protection and respirators should be worn when handling large quantities. HSE document EH44 gives advice on dust

In addition to the materials brought to site the assessment must also consider contamination due to previous use and biological risks from e.g. leaking sewers and agents transmitted to humans from animals, such as leptospirosis.

16.6 Asbestos

Breathing in air containing asbestos fibres can lead to asbestos-related diseases, mainly cancers of the lungs and chest lining. Asbestos is only a risk to health if asbestos fibres are released into the air and breathed in and therefore as dust is not typically generated through Cable Percussion drilling the likelihood of this being a hazard during drilling is low. However, any slurry or damp material that gets on to clothing is often carried into vehicles or the home where it can dry out and become airborne and a hazard.

Building owners and developers are required to carry out asbestos surveys and maintain a register of findings and the regulations also identify duty holders with specific responsibilities for managing the risks from asbestos on sites. The Cable Percussion crew and other site personnel may be at increased risk if works are carried out in or adjacent to buildings where asbestos dust could be generated or where ground containing asbestos is being disturbed. All site staff working on a site where asbestos is considered a possible hazard should have completed an Asbestos Awareness training course.

The Cable Percussion crew should alert the Supervisor, if material suspected to be or contain asbestos is found. If asbestos is suspected, samples should be clearly marked to ensure no laboratory staff are put at risk. Samples of identified asbestos should only be taken by a person who has had asbestos training and can damp down the area, avoid disturbing the material, double bag it, with each bag sealed and labelled, whilst wearing a grade P3 filtered face mask.

16.7 Manual Handling

Before any manual handling or lifting operation is carried out, a suitable risk assessment should be carried out. Risks should be eliminated or reduced to the lowest level reasonably practical.

All personnel carrying out any type of manual handling shall have been suitably trained and certified to do so.

All manual handling must be carried out in accordance with the requirements of the Manual Handling Regulations, HSE Guidance L23. One of the most important recommendations of these regulations is that mechanical means should be employed where available to lift and move items.

Where the use of mechanical means is not practicable, the size, shape and weight of the load should be assessed in order to make arrangements for safe manual handling.

The individual should assess whether they are capable of lifting the load. They should not attempt to lift a load that they consider is too heavy for them. If help is not available, they should not attempt to lift the load. Use mechanical aids where available.

Ensure that items are lifted correctly keeping the load as close to the body as possible. Avoid twisting, stooping or reaching to lift or deposit the load. Do not stop to talk when carrying heavy loads.

Ensure that the route that the load is to be carried over has been assessed and is clear, free from tripping hazards and that lighting is adequate. Avoid carrying loads over rough ground where possible. Find an alternative route if the initial route is not suitable. Get the load e.g. drilling tools and equipment etc. delivered as close to the point of use as possible. Use trestles to hold SPT rods level and at a convenient height to prevent bending down to pick them up.

Wear gloves, safety footwear and any other appropriate PPE but ensure it does not hinder good lifting technique.

Protect any sharp edges of the item to be lifted.

If loads are to be carried for long distances arrange supports to allow the load to be placed on them for brief rest periods. Where practical, load materials and/or equipment into site vehicles and transport between locations. An excavator's bucket can be used to transport materials and equipment over distances.

It is essential to allow sufficient short rest intervals during prolonged periods of lifting. It is preferable to have several short rests rather than prolonged rest periods to allow the muscles to recover.

If more than one person is involved in a particular lifting operation, a suitable person must be nominated to control the operation. Personnel should also be of a similar stature and strength.

When a large load requires lifting, check to see if it is possible to break it down into smaller units e.g. Split sinker bars etc.

Ensure the lifting area is assessed for suitability. Slips and trips, obstructions and sufficient space to complete manual handling task must all be considered.

If possible, provide the correct type of handles or handholds, or use carrying devices to avoid the possibility of trapped fingers etc. especially for items with awkward weight distribution such as trip hammers etc.

Ensure that loose items are made secure to prevent the load shifting when being carried.

Avoid carrying items up and down steps or ladders.

16.8 Work Related Upper Limb Disorders (WRULDs)

WRULDs are conditions which affect the muscles, tendons, ligaments, nerves or other soft tissues and joints in the upper limbs such as the neck, shoulders, arms, wrists, hands and fingers. They are often called repetitive strain injuries (RSI), cumulative trauma disorder or occupational overuse syndrome.

There is a wide range of symptoms, such as tenderness, carpal tunnel syndrome, aches and pains, stiffness, weakness, tingling, numbness, cramp, or swelling.

The employer should make an assessment of the work to determine the levels of risk to which employees are exposed. Tasks carried out in uncomfortable positions such as the removal of samplers while bending, manual handling, and exposure to low working temperatures are some examples.

It may not be possible to eliminate the risk to all WRULDs, as different people respond in different ways to tasks, so there will be a need to monitor employees' health and fitness to detect early signs of problems. Staff should also be encouraged to report any problems.

16.9 Contaminated Land

Site workers involved in contaminated land investigations can be exposed to a variety of substances (e.g. chemicals, dusts, fibres) which can, under some circumstances, have a harmful effect on their health. These are called 'hazardous substances'. If exposure to a hazardous substance is not properly controlled, it may cause ill health in a number of ways. The substance may cause harm by:

- Too much being taken into the body through breathing;
- Being absorbed through the skin;
- Being swallowed or
- Acting directly on the body at the point of contacts e.g. the skin

The following hazards may be encountered on contaminated land investigations;

- Chemical Hazards - either as solid, liquid or gas/vapour including toxic, corrosive and carcinogenic
- Biological Hazard – including pathogens, bacteria, viruses and fungi (e.g. hepatitis, anthrax, Weil's disease)

As stated in Section 13, a Desk Study should be completed including all known or anticipated contaminants and these should be included in the Construction Phase Plan together with COSHH risk assessments and the relevant information passed to the site workers during site inductions.

SECTION 17

WELFARE AND HYGIENE REQUIREMENTS

17.0 Welfare Facilities

Details of what are considered as minimum welfare facilities for construction sites are listed in Schedule 2 of the Health and Safety Executive document L153, Managing health and safety in construction. It is often the case that Cable Percussion drilling takes place well in advance of the construction activity, when no other construction personnel are present on site and before the main welfare arrangements have been made. This is no excuse, however, for the absence of suitable welfare arrangements for the drill crew and other site workers. It is the expectation of the HSE that the level of provision will be commensurate with the duration, location and number of personnel involved and be clearly understood and defined as to what facilities are available and where. This enables arrangements to be made locally for facilities to be shared for such work that is expected to be completed in one or two days for example, and for other work to have mobile facilities brought to site. More detail on what to do on short duration sites can be found in Section 17.6. All other sites should have provisions based on the following guidelines.

17.1 Washing Facilities

Suitable and sufficient washing facilities, including showers if required by the nature of the work or for health reasons, must, so far as is reasonably practicable, be provided or made available at readily accessible places.

General washing facilities must be suitable and sufficient, kept clean and orderly and with basins or sinks large enough for people to wash their face, hands and forearms. Washing facilities must include:

- A supply of clean hot and cold, or warm, water (which must be running water so far as is reasonably practicable);
- Soap or other suitable means of cleaning and
- Towels or other suitable means of drying.
- Rooms containing washing facilities must be sufficiently ventilated and lit.
- Washing facilities and the rooms containing them must be kept in a clean and orderly condition.

Separate washing facilities must be provided for men and women, except where they are provided in a room where the door is capable of being secured from inside and the facilities in each room are intended to be used by only one person at a time. This does not apply to facilities which are provided for washing hands, forearms and the face only.

17.2 Sanitary Conveniences

Suitable and sufficient sanitary conveniences must be provided or made available at readily accessible places.

So far as is reasonably practicable, rooms containing sanitary conveniences must be adequately ventilated and lit. Sanitary conveniences and the rooms containing them must be kept in a clean and orderly condition.

Separate rooms containing sanitary conveniences must be provided for men and women, except where and so far as each convenience is in a separate room, the door of which is capable of being secured from the inside.

Washing facilities must be provided in the immediate vicinity of every sanitary convenience, whether or not also provided elsewhere and in the vicinity of any changing rooms.

17.3 Drinking Water

An adequate supply of wholesome drinking water must be provided or made available at readily accessible and suitable places.

Where necessary for reasons of health or safety, every supply of drinking water must be conspicuously marked by an appropriate sign.

Where a supply of drinking water is provided, a sufficient number of suitable cups or other drinking vessels must also be provided, unless the supply of drinking water is in a jet from which persons can drink easily.

17.4 Changing Rooms and Lockers

Suitable and sufficient changing rooms must be provided or made available at readily accessible places if a worker has to wear special clothing for the purposes of construction work and cannot, for reasons of health or propriety, be expected to change elsewhere.

Where necessary for reasons of propriety, there must be separate changing rooms for, or separate use of rooms by, men and women.

Changing rooms must be provided with seating and include, where necessary, facilities to enable a person to dry any special clothing and any personal clothing or effects.

Suitable and sufficient facilities must, where necessary, be provided or made available at readily accessible places to enable persons to lock away any special clothing which is not taken home or their own clothing which is not worn during working hours and their personal effects.

17.5 Facilities for Rest

Suitable and sufficient rest rooms or rest areas must be provided or made available at readily accessible places.

Rest rooms and rest areas must be equipped with an adequate number of tables and adequate seating with backs for the number of persons at work likely to use them at any one time. They shall include suitable arrangements to ensure that meals can be prepared and eaten and include the means for boiling water and be maintained at an appropriate temperature.

17.6 Transient Sites

Self-contained, fully equipped welfare facilities are available for hire that are based on a large van or small lorry. If it not reasonably practicable to provide at least this level of welfare then, for short term, transient sites the following approach may be acceptable.

On transient sites (less than a few hours in duration), where the work activity is a long way from the site permanent welfare facilities or portable installations on site, the use of public toilet facilities is acceptable provided clear agreement has been made with the provider of the facilities. It should not be assumed that local commercial premises can be used without their agreement. This arrangement is not acceptable where the site has known contamination and the drill crew are likely to have to follow a decontamination procedure before rest breaks or at the end of shift.

In all cases the standards below must be provided or made available:

1. They are readily accessible to the workplace and open at all relevant times and are within 10 minutes of the site in normal traffic
2. Be at no cost to the employee
3. Be of an acceptable standard in terms of cleanliness
4. Have hand washing facilities.

Personnel need to be made aware of the arrangements to use them and be informed of their location in advance of the work starting.

In addition, the site transport or personnel vehicles used by the crew must be equipped with drinking water and means to wash hands e.g. disposable anti-bacterial wipes.

17.7 Health and Hygiene

Good hygiene should be practiced on every site whether there is a known hazard or not. Washing of hands prior to eating and drinking or smoking (if allowed in a designated area on site) is imperative.

Oil or fuel contaminated clothing is a fire and health risk that can cause skin irritation and dermatitis. Such clothing must be changed as soon as possible and cleaned in the correct manner or disposed of. It must not be allowed to remain hanging in any of the site facilities. The use of knit wristed gloves whilst re-fuelling, dealing with cement or working with potentially contaminated materials is prohibited as they may absorb the irritant.

Great care and appropriate precautions must be taken when working in the vicinity of areas infested with rats e.g. foul sewers, drainage systems and streams to ensure that personnel do not contract Weil's Disease.

Advice must be sought from the local water authority and the Medical Health Officer prior to working in, or on, sewers or on waste disposal (landfill) sites. Comprehensive information regarding drilling on landfill sites is contained in the BDA publication Guidance Notes for the Safe Drilling of Landfills and Contaminated Land and within Section 14.

When working in these locations, rubbing of the nose or mouth with the hands must be avoided as should smoking. On completion of the work, hands and forearms must be thoroughly washed with soap and clean water containing an added disinfectant. Any clothing and boots, which have become contaminated, must also be washed, cleaned and disinfected. Any cut, scratch or abrasion should be cleaned, treated with an antiseptic and completely covered until healed, animal droppings, guano accumulations and slurry spray may lead to specific health problems. In all the above cases smoking should not be permitted to minimise the risks from hand to mouth contact.

Should hypodermic or drug taking equipment be found on site work must not start until appropriately trained personnel have cleared that area. The area should also be cordoned off to prevent access until cleared of the hazard.

Relatively harmless materials can cause irritation leading to more harmful effects by repeated or harmful exposure. Every effort must be made to avoid inhaling dust, fumes or smoke. Should working in such conditions be unavoidable suitable personal protective equipment must be supplied to and worn by all personnel.

Prolonged or repeated contact to the skin by substances, chemicals, oils or other fluids can be harmful. Protective gloves / clothing suitable for giving the required level of protection must be worn. These must be provided free of charge. The use of barrier creams is also advised.

SECTION 18

EMERGENCY PROCEDURES, INCIDENT AND ACCIDENT REPORTING

18.0 Emergency Procedures

Every site must have suitable and sufficient arrangements for dealing with any foreseeable emergency and must include for any necessary evacuation of the site or any part of it. Emergency routes and exits should lead as directly as possible to an identified safe area. These procedures must take account of:

- The type of work being carried out
- The nature, size and complexity of the site
- The plant and work equipment being used
- The number of persons likely to be on site at any one time
- The physical and chemical properties of any substances or materials on or likely to be on site.

18.1 Reporting of Accidents

All aspects of the recording and reporting of accidents on the drilling site, base depot or any place of work activity must be carried out in accordance with the requirements of The Reporting of Injuries, Disease and Dangerous Occurrences Regulations (RIDDOR) at all times. Advice on how to comply may be found on the HSE website www.hse.gov.uk/riddor/resources.htm.

All injuries, no matter how trivial, must be recorded in the Employers Accident Book.

All fatal accidents and those resulting in injury requiring hospital treatment, to personnel or members of the public arising from or in connection with work activity, must to be notified as soon as practical to the authority responsible for enforcing the Health and Safety at Work Act in the area of the work activity. This is accepted as telephoning the report. Written confirmation on the appropriate approved form must be made within ten days.

When Employees are detained in hospital for at least 24 hours notification to the appropriate authority must be made. Fatal accidents must be reported to the Police immediately.

All employers are required to keep and maintain records of all accidents and dangerous occurrences and it is strongly recommended that an accident investigation is undertaken and recorded. The BDA requests, in confidence, that all accidents, near misses and/or dangerous accidents are reported to them.

Employers shall have appropriate Employer's Liability Insurance. (ELRIC)

All Lead Drillers and Support Operatives must have up to date Tetanus cover.

For the purposes of Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR), an accident is a separate, identifiable, unintended incident that causes physical injury. In addition to deaths and employees who are unable to carry out their normal working duties for 7 or more days the following injuries are also RIDDOR reportable:

- fractures, other than to fingers, thumbs and toes
- amputations
- any injury likely to lead to permanent loss of sight or reduction in sight
- any crush injury to the head or torso causing damage to the brain or internal organs
- serious burns (including scalding) which:
  - covers more than 10% of the body
  - causes significant damage to the eyes, respiratory system or other vital organs
- any scalping requiring hospital treatment
- any loss of consciousness caused by head injury or asphyxia
- any other injury arising from working in an enclosed space which:
  - leads to hypothermia or heat-induced illness
  - requires resuscitation or admittance to hospital for more than 24 hours

Employers and self-employed people must report diagnoses of certain occupational diseases, where these are likely to have been caused or made worse by their work. These diseases include:

- carpal tunnel syndrome;
- severe cramp of the hand or forearm;
- occupational dermatitis;
- hand-arm vibration syndrome;
- occupational asthma;
- tendonitis or tenosynovitis of the hand or forearm;
- any occupational cancer;
- and any disease attributed to an occupational exposure to a biological agent.

Dangerous occurrences are certain, specified 'near-miss' events (incidents with the potential to cause harm). Not all such events require reporting under RIDDOR. There are 27 categories of dangerous occurrences that are relevant to most workplaces. For example:

- the collapse, overturning or failure of load-bearing parts of lifts and lifting equipment including a Cable Percussion rig;
- plant or equipment coming into contact with overhead power lines;
- contact with an underground electric cable where an injury or fatality could have occurred;
- explosions or fires causing work to be stopped for more than 24 hours.

Certain additional categories of dangerous occurrences apply to mines, quarries, offshore workplaces and certain transport systems (railways etc.).

18.2 Prevention of Accidents

Section 18.1 gives guidance on the requirements for reporting an accident once it has occurred but clearly the emphasis when developing risk assessments and method statement is to provide a 'Safe System of Work' i.e. to ensure that accidents do not happen.

Extensive research over many years and many different industries, has established that there is a clear relationship between the (relatively small) number of accidents of varying severity that occur and the (much larger) number of unsafe situations, incidents and near misses that occur i.e. where the potential for an accident to happen was there, but for whatever reason one had not yet occurred. It has also been conclusively demonstrated that if employers can identify those situations where the potential for an accident occurring exists then they can take action to remedy the situation or amend procedures so as to improve matters before an accident happens.

Such situations might include

- Incidents. Damage to plant, equipment, premises, vehicles or the environment.
- Near Misses. A sudden event has occurred that could have caused injury, death or environmental damage, but did not.
- Unsafe Situation. No event has occurred but it could have done so, with the potential to cause injury, death, damage or harm to the environment.

Both the Lead Driller and the Support Operative are working in an environment which by definition is high risk. They are both in the position of being able and responsible for bringing to the attention of their employer anything they identify which they believe could contribute to an accident occurring.

The BDA, therefore, encourages the open and honest reporting of all unsafe situations, incidents and near misses to their employer in order that improvements can be made before someone is injured, or worse.

18.3 Blood Borne Viruses and Pathogens

Drilling activity is carried out in areas where there is a possibility of contact with infectious diseases with the ensuing risk to the health of personnel. The following are some such diseases: -

- Tetanus
- Hepatitis B and C
- Leptospirosis (there are many types one of which is Weil's Disease)
- Zoonosis
- Lyme Disease (Tics) also known as Hill Walkers Disease
- Toxicara

If there is the slightest indication of a member of the drill team feeling unwell or showing symptoms (most are similar to flu) that cause concern, medical assistance should be sought.

The HSE has published a leaflet advising employers, employees, self-employed, safety representatives, first aiders etc. on how to avoid exposure to blood-borne viruses such as hepatitis and HIV at work. The HSE guidance leaflet is INDG 342 Blood-borne Viruses in the Workplace: Guidance for Employers and Employees.

The employer is required to report and keep records of all diseases as determined by a doctor.

REFERENCES

Acts (Statutory Instruments)

Health and Safety at Work Act, 1974 (HSAWA)
New Roads and Street Works Act. 1991 (NRSWA)
Control of Pollution Act.1989 (COPA)
Environmental Protection Act. 1990 (EPA)

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BS 5930: 2015. Code of practice for ground investigations.
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BS EN ISO 16228-1: 2014. Drilling and foundation equipment. Safety. Common requirements.
BS EN ISO 16228-2: 2014. Drilling and foundation equipment. Safety. Mobile drill rigs for civil and geotechnical engineering, quarrying and mining.

BS ISO 4309: 2010. Cranes. Wire ropes. Care and maintenance, inspection and discard.
BS EN ISO 13850: 2015. Safety and machinery. Emergency stop function. Principles for design.
BS EN 365: 2004. Personal protective equipment against falls from height. General requirements for instructions for use, maintenance, periodic examination, repair, marking and packaging.
BS EN 50104: 2010. Electrical apparatus for the detection and measurement of oxygen. Performance requirements and test methods.
BS EN 50054: 1999. Electrical apparatus for the detection and measurement of combustible gases. General requirements and test methods.
BS EN 50055: 1999. Electrical apparatus for the detection and measurement of combustible gases. Performance requirements for Group I apparatus indicating up to 5% (V/V) methane in air.
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BS EN 365: 2004. Personal protective equipment against falls from a height. General requirements for instructions for use, periodic examination, repair, marking and packaging.
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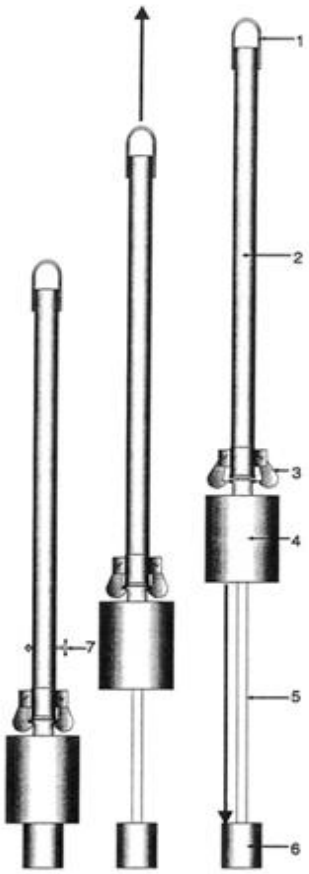


Standard Penetration Test Equipment

SPT Hammer

1 Lifting Loop (LOLER)

2 Sleeve

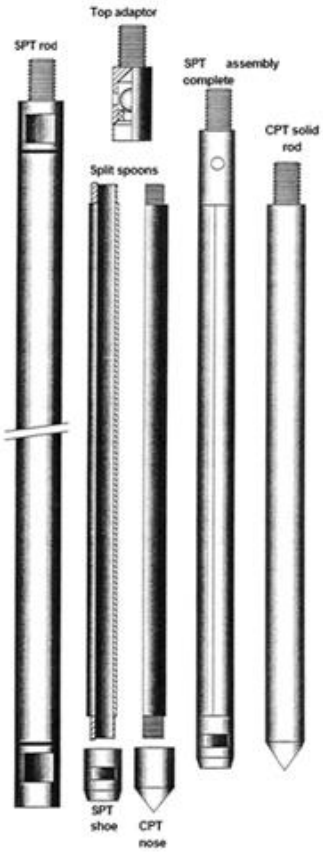
3.Plaws

4.Drop Weight

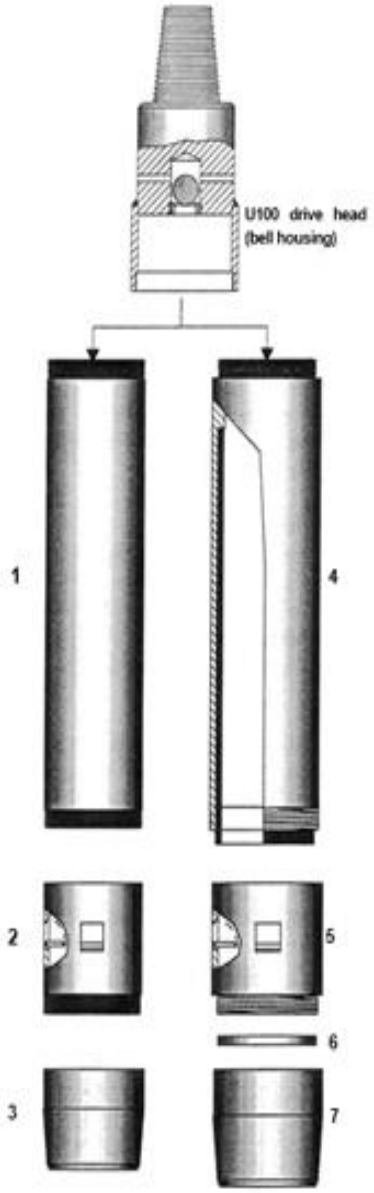
5.Shaft

6. Anvil

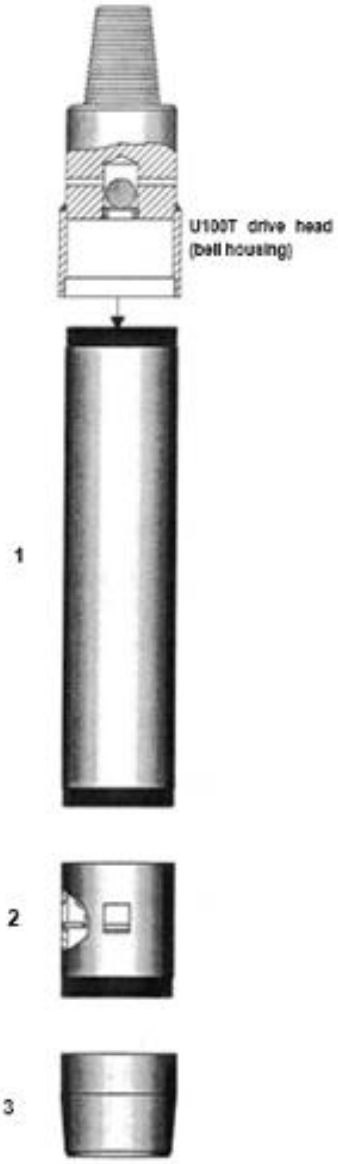
7. Safety Pin



SPT sampler and rod



100 Sampler



UT100 Sampler

1. U100 Barrel
2. Core catcher
3. Cutting shoe
4. U100 liner body
5. U100 Core Catcher (Liner)I
6. Spacer ring
7. Cutting Shoe (liner)

Undisturbed Sampling Tools

CABLE PERCUSSIVE EQUIPMENT

Equipment	Diameter	Length	Weight (Kg)	Equipment	Diameter	Length	Weight (Kg)
12" 300mm drilling equipment				**6" 150mm drilling equipment**			
Casing lead lengths	12" 250	1.50	117.0	Casing lead lengths	6" 150	1.70	64.0
Casing	12" 250	1.00	100.0	Casing	6" 150	1.50	59.0
Casing caps	12" 250	N/A	44.0	Casing	6" 150	1.40	54.0
Casing shoes	12" 250	N/A	17.0	Casing	6" 150	1.30	49.0
Clay Cutter	12"	1.50	116.0	Casing	6" 150	1.20	44.0
Shell	12"	1.50	122.0	Casing	6" 150	1.10	40.0
Stubber	12"		60.0	Casing	6" 150	1.00	36.0
Chisel	12"	250mm		Casing	6" 150	0.90	32.2
Tool shoes	12"	N/A	10.0	Casing caps	6" 150	N/A	13.0
Cutting Rings	12"	N/A	1.0	Casing shoes	6" 150	N/A	5.0
Clacks	12"	N/A	7.0	Clay Cutter	6"	1.50	55.0
10" 250mm drilling equipment				Shell	6"	1.50	57.0
Casing lead lengths	10" 250	1.20	87.0	Stubber	6"		20.0
Casing	10" 250	1.00	72.0	Cross chisel	6"		
Casing caps	10" 250	N/A	23.0	Tool shoes	6"	N/A	4.0
Casing shoes	10" 250	N/A	15.0	Clacks	6"	N/A	1.0
Clay Cutter	10"	1.20	110.0	Shell (undersize)	5"	1.50	45.0
Shell	10"	1.20	118.0	**Sinker bars or Weights**			
Stubber	10"		46.0	Top weights	4 1/2" 114mm	1.00	80.0
Chisel	10"	250mm		Mid weights	4 1/2" 114mm	1.00	80.0
Tool shoes	10"	N/A	11.0	**U100 Hammers and Trip Hammers**			
Clacks	10"	N/A	7.0	Standard U4 hammers	4 1/2" 114mm	1.10	84.0
8" 200mm drilling equipment				Heavy duty U4 hammers	4 1/2" 114mm	1.20	93.0
Casing lead lengths	8" 200	1.70	84.0	2 pull trip hammers	N/A	1.80	105.0
Casing	8" 200	1.50	78.0	3 pull trip hammers	N/A	1.50	115.0
Casing	8" 200	1.40	71.0	SPT complete	2" 50mm	0.75	7.0
Casing	8" 200	1.30	64.0	CPT complete	2" 50mm	0.75	10.5
Casing	8" 200	1.20	58.0	**SPT Rods**			
Casing	8" 200	1.10	50.0	SPT rods round	2" 54mm	3.00	26.0
Casing	8" 200	1.00	43.0	SPT rods round	2" 54mm	1.50	13.0
Casing	8" 200	0.90	37.0	SPT rods round	2" 54mm	0.75	10.0
Casing	8" 200	0.80	32.0	SPT rod swivel			7.0
Casing caps	8" 200	N/A	15.0	SPT Rod Bitch			8.0
Casing shoes	8" 200	N/A	6.0	**Knocking Pins**			
Clay Cutter	8"	1.50	82.0	8" Knocking pin	N/A	N/A	6.0
Shell	8"	1.50	86.0	6" Knocking pin	N/A	N/A	3.5
Stubber	8"		27.0	1.5 ton shackle	N/A	N/A	1.0
Cross chisel	8"	1.50		3.0 ton shackle			1.5
Tool shoes	8"	N/A	6.0	Rec tool for top weigh	N/A	N/A	3.5
Clacks	8"	2.50	2.0	3.0 ton hook	N/A	N/A	2.0
Anciliary Equioment				4.0 ton hook	N/A	N/A	4.5
Rod trestles			10	**U100 Tubes**			
Extruder			7.5	Thin Wall U100			3.5
Timbers (Approx.)			10	Aluminium Wall U100			3.0
25lts water			25	**Samples Weights**			
Chain tongs			6	15m CLAY = 6 x U100 15 x Ds 6 x Bs			210
Sledge hammer			7	15mSAND = 15 x Ds 12 x Bs			250
2 people 90kgs each			180	B samples Average			**15**
PPE			15	Disturbed or tub samples			**2**
Small equipment			20	U100 sample full of clay			11
Full tank of fuel			75	Water sample 1 per lt			1

Source: BS EN 16228-1

Instruction selecting and fitting of wire rope grips for free fall application

General

The following instructions are applicable to ropes utilising wire rope grips used in a freefall application.

Other designs of grip may be used providing they have been satisfactorily tested by the grip manufacturer, and sustain minimum of 80% of the minimum breaking load of the rope. Installation of the grips shall be in accordance with the grip manufacturer's instructions.

Installation

The distance between the grips shall be at least 1.5 times, and not more than 3.0 times the thickness of the bridge, "H" (see Figures .1 and .2).

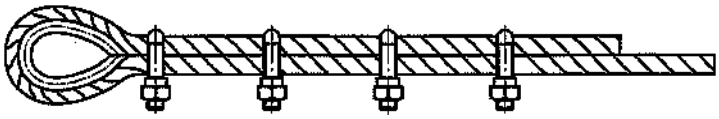


Figure 1 — Installation and spacing of grips

When using a thimble in the eye, the first wire rope grip shall be placed immediately against the thimble. The bridge shall always be placed on the load bearing part of the rope.

Never saddle a dead horse

Number of grips

The recommended number of grips to be used is given in Table 1 below.

Tightening torque

When making the assembly, and before bringing into service, the collar nuts shall be tightened to the torque given in Table 1 below.

The recommended tightening torques are for grip with the bearing surfaces and threads of the nuts greased. After the load has been applied a few times, the torque shall be checked.

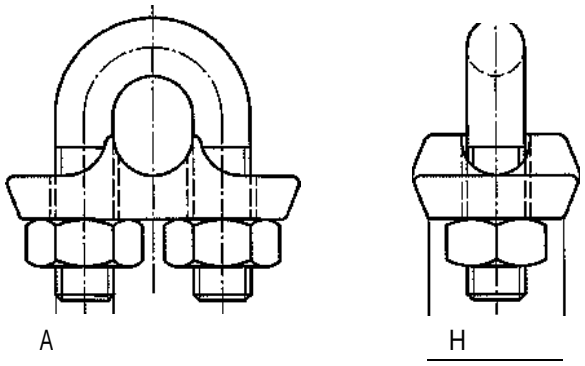


Figure .2 — Thickness and tightening thread diameter

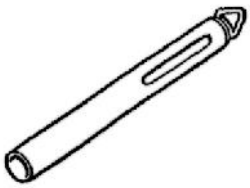
Table 1 — Number and torque of wire rope grips

Nominal size of grip to suit wire rope diameter mm	Number of grips	Tightening thread diameter	Tightening torque Nm
14	4	M12	33
16	4	M14	49
19	4	M14	68
22	5	M16	107
26	5	M20	147
30	6	M20	212
34	6	M22	296
40	6	M24	363
For intermediate sizes of wire rope, use next larger grip size.			

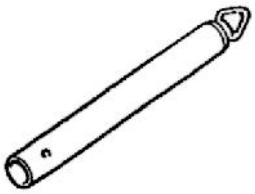
The type of wire rope suitable for a Cable Percussion rig is defined by the manufacturer to be a fibre core left lay, however, it is very important that the correct factor of safety (FOS) is applied before selecting the correct size of rope, shown in red in the table below

Rope diameter mm	Mass per 100m Kgs	Max breaking load Tonnes	SWL FOS 5:1 Tonnes	SWL FOS 3.5 :1 Tonnes
11	43.7	7.21	1.4	2.6
12	52	8.57	1.7	2.44
13	61	10.1	2	2.88
14	70.8	11.6	2.3	3.31
16	92.4	15.3	3	4.37
18	117	19.3	3.8	5.51
19	130	21.5	4.3	6.14

The Cable Percussion equipment below, all fall under the title of a lifting accessories. This requires that all of the items listed require a thorough inspection under the Lifting Operation and Lifting Equipment Regulations (LOLER) at least every 6 months or more frequently should the competent person feel it is necessary. Each item must be uniquely identifiable and carry the identification of its safe working loads (SWL). LOLER does not apply to casing and rods as these are deemed as drilling tools and not lifting accessories as lifting is not their primary role.

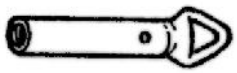


Slotted Sinker Bar

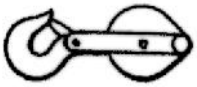


Solid sinker bar

Sinker Bar Swivel

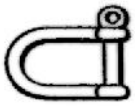


Rod Swivel



Snatch or pulley block

Clevis and pin



D or bow shackles

SPT lifting point

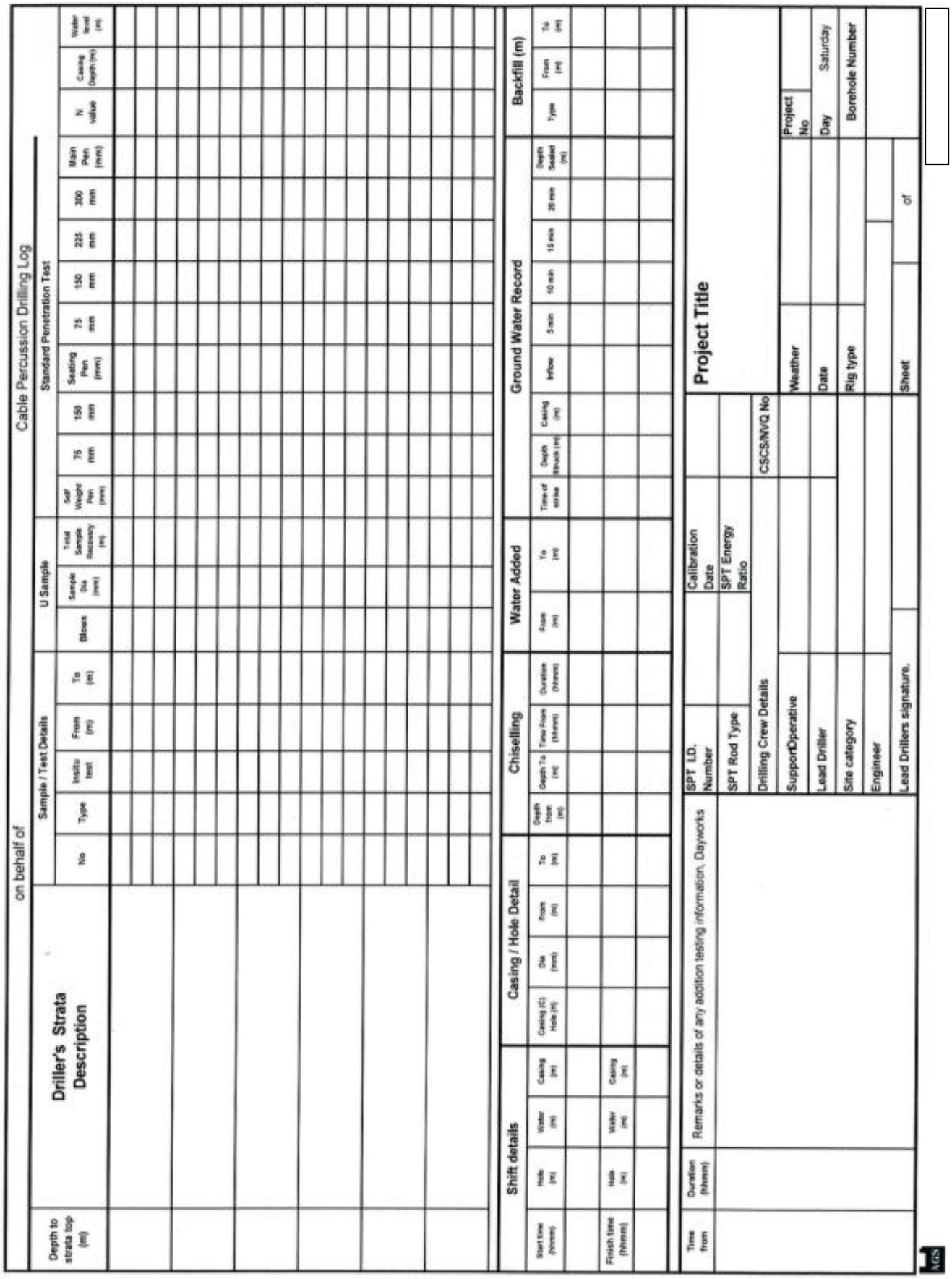
Lifting accessory showing unique identifier and safe working load (SWL)

APPENDIX E
EXAMPLE DAILY INSPECTION SHEET

Date of report	
Location of inspection	
Rig Unique number	
Rig Manufacturer	

Main components	NAD (No Apparent Defect)	Comments
Is the winch guarded in line with PUWER		
Is the engine guarded in line with PUWER		
Chain or belt guard guarded in line with PUWER		
Engine is free from leaks		
Engine mountings secure and complete		
Operation of emergency stop		
Exhaust system secure and complete		
Winch general condition		
Gearbox security and condition		
A frame free from cracks and bends		
Front legs free from cracks and bends		
Base plate free from cracks and bends		
Side stays and cross bar fitted correctly and secured		
Side stays free from crack and bends		
Crown wheel Pulley block attaching point		
Condition of the main crown wheel		
Crown wheel rope retainers and loops		
Winch operates correctly		
Winch Foot brake works efficiently		
Winch Hand brake works efficiently		
Foot brake anti slip condition		
Condition of wire rope		
Type of wire rope		
Wire Rope Grips (state number)		
Rope termination condition		

Transport		
Road wheels braking condition		
Road wheel hand brake condition		
Road wheel tyre condition		
Mud guards secure and complete		
Rig lighting correct and complete		
Rig raising winch (if fitted)		
Condition of winch rope		
Is the winch guarded in line with PUWER		
Condition of pulley wheels		
Security of winch to main frame		
Condition of remote control		
Overall comments		
Signature of person marking this report		Date



Cable Percussion Rig Inspection Sheet

Project				
Rig Type			Rig ID	
Engineer			Date	
ITEM	CHECK			
Health and Safety	SAFE	CONCERN	UNSAFE	
Does the drilling operation look safe				
What Safety Signage is in place				
Where is the First Aid Kit located				
Where is the Fire Extinguisher located				
Is all PPE & RPE available (Spares available)				
Is any specialist PPE / RPE required during drilling				
Operational Rig Safety - General	SAFE	CONCERN	UNSAFE	
When was the rig last serviced (PUWER)				
Is the rig in good working order				
When was the rig last thoroughly inspected (LOLER)				
Does the rig have a valid LOLER certificate				
Are Emergency Stops clearly marked and working				
Are harness points located on the mast				
Is a climbing harness available & emergency plan in place				
Is the rig set up on flat ground or suitable timbers				
Is there any visible damage to Electrical Wiring				
Are both side stays secured in place with bolts and nuts/pins				
Is the cross bar secured in place with bolts and nuts/pins				
Does the rig have a suitable Samson Bar				
Can the rig be raised without assistance				
Is the rope jump bar in place to the crown sheave				
Is the Winch Wire in good condition				
Is the secondary Winch Wire in good condition				
Are the Winch Wires correctly terminated				
Is a LOLER certificate available for all lifting equipment				
Is the exhaust venting away from the driller				
Operational Rig Safety - Guarding	SAFE	CONCERN	UNSAFE	
Is a fixed guard covering the winch drum				
Is a fixed guard in place over the chain and sprocket				
Is a fixed guard in place over the capstan wheel				
Is a fixed guard over the clutch / crank spindle				
Environmental	SAFE	CONCERN	UNSAFE	
Does the rig have any engine / hydraulic oil leaks				
Is a spill kit available				
Is there any other means to contain leakage i.e. drip tray				
Additional Observations, Comments and Actions			Checked By	
				PASS
				FAIL

NOTES