Κώδικας Πρακτικής για την αντικατάσταση κύριων αγωγών με τη μέθοδο της κατευθυνόμενης διάτρησης (guided moling and horizontal directional drilling)

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CODE OF PRACTISE FOR MAINS REPLACEMENT- Guided Moling and Horizontal Directional Drilling (HDD) for Polyethylene (PE)

1. SCOPE

This code of Practice is intended for guidance by Engineers or their representatives responsible for the replacement of existing mains by guided moling and drilling and should be used in conjunction with the corresponding Procedure for operational personnel.

2. REFERENCES

Unless otherwise specified this document shall be used with reference to the latest editions of related procedures, standards and specifications dealing with safety, construction planning, traffic management, excavations, reinstatements, materials, plant and equipment, testing and commissioning.

3. DESIGN AND METHOD SELECTION

3.1 General

Whilst guided moling and drilling is a most suitable technique for new mains and services installation, it can also be a most cost-effective method for mains and service replacement. Generally in high population density areas, where there are many service connections to consider and also where environmental factors can be a major constraint, directional moling and drilling can often be preferable to other methods.

In the case of mains insertion or swagelining, and even where service replacements have been undertaken in advance, the number of service transfer/connection pits can be very disruptive to the local community. This may also involve labour intensive operations on restoration of gas supplies, especially where overland bypass mains and temporary service connections have not been installed.

Service transfer excavations, if left open will require a high level of protective barriers, road cones, traffic lights, signs, etc; or alternatively, traffic conditions may dictate that the excavations are plated over with heavy duty steel road plates involving placement and removal using lifting plant.

Environmental factors to consider are the locations of existing gas mains, prevalence of other utilities apparatus, road traffic congestion, rail, river and water course crossings. In certain circumstances, it may be preferable to re-locate the position of a replacement main rather than carry out existing “in-situ”mains rehabilitation. For example, those mains situated in close proximity to, or beneath buildings, structures, ornamental features and plant installations, or other inaccessible locations, or those that may be at shallow depth and subject to potential interference damage or alternatively have been subject to landfill overburden.

Guided moling or drilling offers an effective technique to overcome some of the difficulties associated with other mains replacement methods. It has the added benefit that service replacement and transfers can be carried out after the replacement main has been installed on a less labour intensive basis and without the need to provide overland bypasses and temporary supplies to customers, whilst the existing main still remains in commission.

In the case of guided drilling, the procedures detailed in Parts A & B are typical operations which may need to be varied due to the wide range of equipment available, each with its own steering mechanisms, different power ratings and lubrication needs. Guided boring equipment can be either percussive/pneumatic, hydraulic, or rotational in action or a combination of these functions and they are described below.

3.2 Percussive Impact (soil displacement) Mole

Impact moling is generally the most widely used trenchless pipelaying technique and is mainly used for small diameter pipelines over short lengths. Typically, steerable impact moles (hammers), will install PE pipe in the diameter range 16mm to 63 mm within a 75mm diameter bore-hole, and at lengths of up to 60 metres, depending upon ground conditions. Non-steerable, unguided impact moles are available in larger diameters and can be fitted with an expander/mandrel, to install PE pipe up to and including 250 mm diameter but may have length limitations of only up to 25 metres. Provided prior safety precautions are taken regarding the proximity of utilities apparatus, the steerable mole can be used to produce a pilot bore-hole for single or multiple passes with the use of the larger diameter non steerable impact mole. Alternatively, where pilot boreholes are relatively straight, a winched-in expander/mole could be used in between launch and reception pits to produce a larger diameter bore. For greater distances, the practice of "stitching" can be employed.

The performance of the mole depends upon the type and condition of the ground in which it is operating. The percussive action of the mole has the effect of compacting the earth around it, and therefore the impact mole can only be used in soils and soft friable, shales which allow for this compaction, without potentially causing damage to adjacent underground apparatus or ground heave. Impact moles can operate in most clays, silts, sands, aggregates and gravels. Isolated cobbles and small boulders are displaced or broken up, although they may tend to deflect the bore off-line. Very soft ground conditions are unsuitable, as the mole tends to drop under its own weight, which is more significant for moles greater than about 75 mm in diameter.

As applies to all guided boreholing methods, before moling commences, it is essential that records of all underground services are studied to ensure that there are no pipes, ducts or cables likely to obstruct the pipe "drive" route between launch and reception pits. Also a safe proximity distance as specified by the utilities concerned, shall be maintained between the proposed bore and other plant in the vicinity. Trial-hole excavations, pipe and cable detection equipment together with visual inspection shall be used. Trial holes excavated during the site survey, and used to either verify the position the utilities underground records or to check ground conditions or that the proposed "drive" is clear of obstructions should also be considered for use as launch/intermediate and reception pits. These in turn could also be used for mains and services connections

and transfer pits, with possibly several service connections made, and radiating from the same pit.

Guided moling commences just like a non-steerable impact mole with a launching cradle, which safely aligns the machine, and a sighting frame used to aim the mole at the required target area. A hydraulically operated device called a “Torquer” (steering wheel) and control unit are fitted at the sighting frame to start, stop, forward, reverse, fast/slow or manoeuvre the mole.

Two pits are excavated, one to launch the mole and one to receive it. The launching pit will typically be about 2 metres long and up to 1 metre wide and approximately 1 metre deep. The reception pit should be at least the length of the mole plus about 200 mm to allow for its removal or possibly larger in the case of mains stitching where the reception pit becomes an intermediate pit to launch the mole again and extending the distance of installed pipe. To avoid misalignment of bores between launch, reception and intermediate pits when stitch moling is used, it is recommended that the mole is allowed to continue through, and a mole’s length past the intermediate pit. It can then be reversed and removed and set-up again as a separate launch operation in the intermediate pit and targeted towards the next reception pit. It is good practice to ensure that wherever possible to minimise excavations, that as much use as possible is made of each excavation pit for multi-purpose operations.

Once the mole has emerged from the target pit and the compressed air supply safely isolated, the mole is disconnected from the air hose which is reconnected to the PE pipe to be installed via a pipe-puller. By pulling the hose out of the borehole, the PE pipe is simultaneously pulled in.

Whilst the pneumatically powered impact mole only operates at an average speed of 10 metres/hour, it is essential that its exact position, line and depth are continuously monitored and recorded during the guided moling operation. This is achieved by using a specialist radio-detection instrument and a transmitting sonde, located in the head of the mole, which provides pitch, depth and roll information. These details are regularly passed on from the person tracking the mole to the steering operator, so that both operators have a clear picture of the machine location, to ensure any necessary course corrections are made.

Depending upon ground conditions, radius of curvatures of the borehole line can possibly be around 27 metres or less with certain machines, to course correct, avoid potential obstructions or maintain safe proximity distances from other underground apparatus. However, advice should always be sought from manufacturers and suppliers on the limitations of use for their particular machines.

Installation procedures for operational personnel are detailed in Part B of this procedure, together with safety and risk assessment requirements provided in Appendix A.

Although, more powerful, larger diameter, guided, pneumatic and hydraulically operated, soil displacement impact moles are in development, the same principles, as above, will also most likely apply to such future improvements in technology.

3.2.1 Summary

Guided impact moling is usually considered preferable to guided drilling methods as it offers the following advantages:

a) Minimal skill and training requirements. Usually "on-the-job" training by a qualified and experienced operator/instructor that is normally provided by the equipment supplier is sufficient.

b) Capital investment, operational and maintenance costs are relatively low.

c) Easily transportable by commercial vehicles with no heavy duty lifting equipment required.

d) Causes least disruption to customers, road users and the general public.

e) It is most useful for small diameter, short length mains and service renewals, including road crossings and house connections, under gardens and pavements up to 60 metres in length, depending upon ground conditions.

f) It is suitable for average ground conditions including sand and clay.

g) No expensive drilling rod stems, drilling bits or back-reamers to consider, no "bentonite" drilling fluid to mix, no water supply required, and no waste disposal costs including disposal of drill cuttings and surplus "bentonite" fluid.

However impact moling does have its disadvantages as follows:

a) Compaction of the surrounding soil, which is displaced during the moling operation, could cause a problem, especially in outcrops of hard compacted ground, containing rocks and large boulders, which could make progress slow and difficult.

b) There is a high potential risk to interference damage to other services in the vicinity with difficulty to determine if there are any uncharted or unrecorded obstructions in the "drive" path of the mole and in between excavation pits.

c) Largely due to ground conditions, guided impact moling is generally restricted to small diameter, short length mains and service replacements only.

d) The inserted PE pipe is untraceable using traditional pipe location instruments and consequently accurate records need to be maintained.

e) Impact moling is slower than guided drilling which is usually up to 10 times faster in average ground conditions.

Guided drilling methods will overcome some of the limitations of impact moling and are described in section 3.3.

3.3 Guided and Horizontal Directional Drilling (HDD)

Directional drilling is a very specialist operation, requiring the use of highly trained, qualified and experienced operational personnel who are accustomed to using the equipment on almost a regular daily basis.

Guided, directional drilling machines, generally operate in pipe diameters ranging from 50 mm to about 1000 mm, and at "drive" lengths from a few metres to several kilometres, depending upon the specification of the machine selected.

There is a large assortment of guided drilling rigs available, and it is recommended that the Engineer/Manager consults with equipment suppliers to establish various machine specifications and decide on the particular machine necessary to suit the required circumstances.

The range of drilling machines available are usually categorised as a mini, "medi" or maxi classification but design and installation practices will vary between machines.

However, for gas distribution purposes, the mini and "medi" machines are those most considered appropriate for mains replacement. Consequently, this procedure excludes machines in the "maxi" category, which are usually used for crossing lakes and large estuaries.

The mini and "medi" machines are generally rated in accordance with their pullback power, i.e. up to a maximum of 4 tonnes force for mini, and between 4 and 20 tonnes force for "medi". Those machines operating in excess of 20 tonnes force pulling power are classed as "maxi".

3.3.1 Installation Guidelines

Guided/directional drilling is carried out from a large surface mounted rig with a drill lubrication system, usually "mud" pumped down the drill-hole, drives the drill at the end of the bore and carries the cuttings back out of the launch hole as it re-circulates.

It is usual practice, except with small pipes (< 75 mm dia.), that the first drill hole is used as a pilot bore to establish line and level before reaming to the required diameter.

Once reamed, the PE insertion pipe is attached to the end of the drill string in the reception pit and pulled back through to the launch pit. Pulling forces shall not exceed half the specified minimum yield stress (SMYS) of the PE pipe in accordance with those tension limits expressed in Table 3 (Part A) and Table 4 (Part B) of the "Mains Insertion Procedure".

The length and diameter of the pipe to be installed is very much dependant on the type of machine employed, but in general, the "pull-back" force rating of whatever machine is used is the deciding factor. An estimate of the weight of the pipe to be hauled through the bore-hole with an allowance for frictional effects (say 20% uplift) is recommended and compared with the pull-back force specification of the machine employed to make sure that it is not under-rated.

All guided/directional drilling machines shall be fitted with approved safety equipment, including the use of a “Faraday Mat” which shall be adequately earthed, and a cable strike alarm, to protect the operatives from any accidental electricity cable strikes.

The guided drilling equipment shall be capable of being guided in both vertical and horizontal directions.

Launch and reception pits should be of sufficient size to enable the proper execution of the work, but usually not exceeding 5 m² for the launch pit and 3 m² for the reception pit.

Wherever possible the minimum distance between launch and reception pits shall be 50 metres.

The tolerance for guided drilling shall be ± 150 mm from the design line and level, produced on drawings for use by operational personnel.

For PE pipe “pullback” purposes, it is recommended that the line of the drilled bore should not exceed a radius of 30 installation pipe diameters, and changes in direction achieved by bending the PE pipe shall not be less than a bend radius 15 times the pipe outside diameter. No joints, either butt-fused, electrofusion or approved mechanical be permitted within the cold–bended pipe. Where this is not possible, an intermediate excavation may be required in which to install a standard bend.

The drilling machine rig, can be either static or mobile on rubber tracks, the static machine, held within a drill frame can be used in-ground within the launch pit or as applies to the mobile rig, can also be used at surface level.

When mounted at surface level, the drill is usually inclined at a launch inclination angle of between 10° and 18° depending upon differences in surface levels and can also be steered up gradients, perhaps near the reception pit at these angles.

The mobile drilling rigs and larger static machines are usually self-contained with easily detachable drill rod boxes containing usually up to 50 (3 m length) drill rods. The drill rods are usually automatically loaded and unloaded for back reaming and where greater “drive” or “shot” lengths are required, the rod box can be easily and quickly exchanged for a second rod box within minutes.

Accurate depth and location information should be recorded on a drilled bore log sheet at a minimum of 5 metre intervals, for all lengths of the PE pipe installed by directional drilling. Proprietary, hand- held computers, bore planner software and printer outputs are normally available for all guided drilling machines as an optional requirement. The lead drill bore head contains a transmitting “sonde”, the location of which is detected at surface level using a radio detection receiving instrument.

Installation procedures for operational personnel are detailed in Part B of this procedure, together with safety and risk assessment requirements provided in Appendix A.