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ΕΔΑ-WS-006

Προδιαγραφή εργασίας για την αντικατάσταση κύριων αγωγών με τη μέθοδο της κατευθυνόμενης διάτρησης (Guided moling and horizontal directional drilling)

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PROCEDURE FOR MAINS REPLACEMENT- Guided Moling and Horizontal Directional Drilling (HDD) for Polyethylene (PE) PIPE

1. SCOPE

This procedure gives guidance for operational personnel engaged on the replacement of existing mains by guided moling and drilling and should be used in conjunction with the corresponding Code of Practice.

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. SAFETY

3.1 General

3.1.1 Unlike other trenchless replacement methods, such as mains insertion/sliplining, or swagelining, which involve rehabilitation of the existing main, all guided boring methods are used "off-line". Consequently, this means that there is a considerably higher risk of danger to operatives with the potential hazard of accidental damage to utility apparatus, especially gas pipes or electricity cables in the vicinity of any proposed boring operations. (See – "Site operators safety guide" - Appendix A).

3.1.2 Detailed working instructions and procedures i.e. "Operators Manual", for the use of the particular plant/equipment employed, should be obtained from the supplier, complied to, and used. In addition, all safety instructions, data sheets, and assessments of any substances hazardous to health, including lubricants, powdered "bentonite" type materials and additives, should also be obtained from suppliers and used.

3.1.3 Personal protective clothing shall be worn in accordance with company safety instructions and procedures, as well as those specified by suppliers.

Excessive contact with lubricants should be avoided. When handling these materials, plastic disposable gloves, suitable eye protection (goggles) and facemasks should be worn. An approved gauze face mask and goggles shall be worn when working within 1 metre of the exhaust from pneumatically powered impact moles.

When noise levels are considered to be sufficiently high, ear defenders (muffs), shall be worn during boring operations.

3.1.4 Special care shall be taken during boring operations when the operator has direct metallic contact with the equipment. Attention shall be made towards avoidance of danger from cables using a cable avoidance tool (CAT).

3.1.5 Operators shall not stand in the reception pit, because of the risk of being struck by the guided mole/drill, or in unsupported deeper pits where there is the risk of ground collapse as the mole/drill enters the pit.

Whenever practicable, the operators should stand clear of the borehole to avoid the risk from a sudden blast or discharge of air, lubricant or debris along the bore. No attempt shall be made to closely watch the progress of a mole/drill through the mouth of an impacted bore.

3.1.6 The equipment shall not be allowed to operate unattended.

3.1.7 A safety isolation valve or an emergency stop button shall be sited in a readily accessible position in order that the operator may stop the machine in an emergency.

3.1.8 A site specific risk assessment shall be undertaken in accordance with the requirements of the "Site Operators Safety Guide" as provided in Appendix A, before guided moling/drilling commences. Site specific risk assessments will vary between different jobs, but as a guide, examples for directional drilling are detailed in Appendices B and C of this procedure.

4. SITE SURVEY

4.1 Where practicable, information on the position of plant in the vicinity of the proposed line of the moling/drilling operation shall be obtained. On site checks, including the use of plant location shall also be made to locate and, where appropriate, to confirm the position of buried pipes and cables.

Where the Engineer considers it necessary, site meetings with representatives of other utilities and plant owners should take place.

4.2 A survey of the proposed route of the operation shall be carried out to establish the line and level of all other existing underground plant. The survey should include the use of cable and pipe locators and the lifting of inspection covers to determine depths of plant where applicable. The line of underground plant should then be clearly marked on the ground surface. If there is any doubt about the validity of underground plant information within the vicinity of the proposed bore, trial holes should be excavated to expose the plant.

4.3 Where manholes are to be lifted, proper lifting equipment shall be used and care taken to avoid sparks or damage to underground plant or covers. Suitable action shall be taken to ensure the safety of pedestrians and other road users. The appropriate authority should be notified where necessary.

4.4 Once a preferred route has been established, further trial holes may be necessary to ensure freedom from obstructions on that route as well as check suitability of ground conditions for either moling or drilling. The use of a small diameter pilot bore hole may be considered prior to a larger diameter moling/drilling operation, in order to confirm the viability of the selected route and to provide alignment for the larger mole or drill reamer.

5. PROXIMITY TO OTHER PLANT

The accuracy of the line of the bore is dependent upon three main factors:

a) the skill, communications and care exercised by the operators of both the guided boring machine and tracking equipment used to monitor progress to ensure the mole/drill does not deviate from its planned path.

b) the characteristics of the soil and ground conditions.

c) the characteristics of the individual guided moling/drilling machine used.

5.1 Where guided moling/drilling is to be used several times at one location, sufficient hand excavated trial holes shall be made to confirm the position of all underground plant.

5.2 In general, the machine should be aligned to give the maximum clearance from other underground plant, but not less than 250 mm clearance for all bore lengths. The Engineer shall decide whether to increase, decrease or maintain these clearances after evaluating the site specific risk assessment, previously undertaken, or to cease the moling/drilling operation.

When moling, consideration should be given to the effect of soil displacement on adjacent underground plant, especially when using moles greater than 100 mm diameter.

5.3 Where appropriate, consideration should be given to excavating on, or alongside significant plant, in order to ensure that it does not obstruct the free passage of the mole/drill.

All boring should be carried out below the construction depth of a “made-up” or finished surface.

5.4 The minimum depths of cover as specified in company procedures shall apply or 7 times the diameter of the reamed-out, or expanded, finished borehole, whichever is the greater.

6. PREPARATION OF THE SITE

6.1 All excavations shall be carried out and protected in accordance with company excavation procedures.

6.2 To minimise risk of damage to underground plant, it is recommended that the guided mole or drill be launched from the most congested side of the proposed “drive” route or crossing. For services, consideration should also be given to commencing the bore at the main, to ensure accuracy at the connection to the main.

The depth to mole/drill diameter ratio may be varied at the discretion of the Engineer.

6.3 The launch pit should be excavated to the minimum required size, depending upon the boring technique used, and provision should be made for:

a) Removal of the mole or drill head at the reception pit.

b) Reversal of the mole or drill, pulling PE pipe behind it.

c) Where the process of pipe "stitching" is used, intermediate pits may have to be expanded to allow for their subsequent use as new launch pits.

7. MACHINE OPERATION AND PE PIPE INSTALLATION

7.1 General

7.1 1 Machines should be operated and maintained in accordance with individual machine operating instructions.

7.1 2 Every precaution shall be made to protect the PE pipe from damage or ingress of lubricants, water or debris. Suitable rollers shall be provided at the pipe insertion pit and for the full length of any straight welded pipe strings and plastic end caps or rubber stoppers used to prevent ingress of foreign substances.

7.1.3 As-built drawing records, should be prepared, following installation of the polyethylene pipe and produced for the attention of the Engineer.

7.2 Guided Moling

7.2.1 Where large diameter moles with expanding heads are used, additional precautions may be necessary with respect to:

a) depth of bore and ground heave;

b) winching arrangements;

c) mechanical handling.

The importance of each of these requirements will depend upon the circumstances applicable on site, and shall be determined by the Engineer. Safe use of excavators for mechanical handling and lifting purposes and safety of winching operations are both detailed in Appendix A and Appendix B of the Part B procedure for mains insertion.

7.2.2 The minimum depth of bore and proximity to other plant shall be as described in clause 6.

7.2.3 Both launch and reception pits shall be re-surveyed with pipe and cable location equipment before commencing operations. The base of the launch pit shall be flat and reasonably level and compacted for setting up the launching cradle and aiming frame. Extreme care shall be exercised when driving in cradle anchor spikes and survey poles.

7.2.4 Distance markers (coloured PVC adhesive tapes) can be used at intervals on the machine supply air hose to monitor progress or locate the position of any rock outcrops or other obstructions or unexpected route deviations. Additional (colour-coded) markers may also be fixed to indicate the expected positions of underground plant, where additional care may be required. Although the depth and location of the mole is tracked using a sub-site locator, readings may sometimes be lost or in error especially where there is a prevalence electromagnetic radiation from above or below ground high voltage electricity cables. The moling operation shall be stopped and interrupted in these circumstances and not allowed to continue until the Engineer has identified the source of the problem. Any faulty locators, batteries or transmitter sondes should be replaced before work re-commences.

A written depth, distance, direction and line log should be recorded between launch and reception pits.

7.2.5 Moles which cannot accept full compressor pressure, shall only be used in conjunction with an approved regulator set to the appropriate maximum pressure limit specification of the mole, to avoid damage to pressure seals etc.

7.2.6 For satisfactory operation of the mole, it is necessary to ensure that an adequate supply of an approved lubricant is delivered to the mole in accordance with the machine operating instructions.

7.2.7 The alignment of the mole shall be set-up before launching, using the sighting frame and re-checked by others before proceeding. If any error is found, the mole should be realigned.

7.2.8 During the operation, the progress and position of the mole shall be constantly monitored. If it is suspected that the mole is deviating from its planned route which cannot be corrected by the “torquer” steering wheel device, or has met an obstruction, the machine should be stopped and the cause investigated.

7.2.9 Care shall be taken to slow down the mole as it enters the reception pit. Damage to the machine and any other plant in the reception pit may result if this precaution is not taken.

7.2.10 The first hole bored can be used as a pilot hole, for enlargement using larger diameter moles fitted with expander heads in order to install larger diameter pipes.

7.2.11 Following completion of a successful boring operation, the PE pipe should be inserted in accordance with the mains insertion procedure. PE pipe of nominal diameter 63 mm and above may be pulled in behind a mole.

7.3 Guided drilling /Horizontal directional drilling (HDD)

7.3.1 Only a trained and certified machine operator, who is fully conversant with the operation, procedures and maintenance requirements of the particular machine to be used, shall be permitted.

7.3.2 All machine safety checks shall be undertaken in accordance with manufacturers instructions, with particular attention to safety covers and guards on moving and rotational parts, emergency stop button, cable strike alarm and “Faraday Mat” earthing facility.

7.3.3 Prior consideration should be given to site haulage and lifting requirements, especially with static guided drilling machines. Self-drive “tracked” mobile machines are usually transported to site using de-mountable trailers or articulated lorries depending upon the size of the machine. Once on site, self-propelled units can be driven between launch and reception pits, without further transport or lifting requirements.

7.3.4 Prior attention to lubrication and drilling fluid supply, use of and disposal is necessary. Although the smaller machines tend to have self contained, lubricant storage and mixing tanks, the larger machines normally require up to a 2,500 litre capacity plain water storage tank and a 2,500 litre “bentonite” or polymer drill fluid mixing tank. Unless water is transported to site using water tankers or “bowsers”, a water supply will be required on site from either local water utility stand-pipes, or abstraction from a nearby water course. Permission is normally required from the authority concerned in both of these instances. Large water and mixing tanks will require extra provision for transportation, when used at different locations on the job.

7.3.4.1 Biodegradable lubricants and oils should be used whenever possible, and safe handling of these chemicals as detailed in the safety data sheets provided with the supply of these materials should be observed.

7.3.4.2 Depending upon the type and size of guided drilling machine used, additional protection to excavations may be necessary. Launch, reception, intermediate or adjoining excavations could overfill with drill cuttings and drilling fluid. The excavations should be of sufficient size to contain the same volume of drilling fluid as that stored, particularly in the launch pit. Additional special precautions and security to prevent access by pedestrians or accidental falls into the excavation using close-linked, un-scaleable, 2 5 metre high steel reinforced mesh fencing may be necessary, subject to the Engineers discretion.

7.3.4.3 Where the Engineer considers it necessary, the sides and base of the drill pits should be lined with an impervious material such as plastic sheeting and, trench supports used to prevent ground collapse. All possible sources of pollution (i.e. entry and exit points) or potential over-spill from the excavations should be contained using up to two courses of sandbags in or around excavations. Spill kits should be readily available on site to absorb any accidental spillages of oil, diesel or drilling fluids.

7.3.4.4 During and after the drilling and PE pipe insertion process, attention will be required for the continuous removal of drill cuttings and surplus waste drilling fluid from the excavations. This is usually undertaken in the case of larger machines, by a waste slurry suction tanker, of the type used by the agricultural or sewage slurry industry for disposal to an approved waste facility.

7.3.5 Depending upon the specification of the machine used, the drill entry angle at the launch pit needs to be carefully considered as this affects the dimensions of the launch pit.

7.3.5.1 In the case of in-ground, static drilling machines, used below surface level and where a drilling shaft can be excavated, the surface area dimensions of the launch pit can be kept to a minimum as the entry angle can be as low as 0° to the horizontal. Depending upon the launch angle and depth of the drilling shaft required, the use of in-ground drilling could possibly require the need for extra trench supports, including trench ladders for use by operational personnel.

7.3.5.2 Where above ground, surface mounted machines are used, the usual drill entry angle of anywhere between 10° and 18° to the horizontal plane, (although this varies between machines), will mean larger surface area launch pit dimensions which could be as much as 3 m² or more for safe working.

7.4 Before drilling commences, the entire surface of proposed route between launch and reception pits shall be surveyed, with particular attention to colour-code marking the positions of all underground plant, using proprietary biodegradable road paint sprayed on the surface. Man-entry covers, should be lifted and depths from surface to invert level (bottom of pipe, drain or duct), diameters of sewers/drains/telecom. ducts and cover (from top of pipe/duct to surface level) recorded. In accordance with the pre-prepared site specific risk assessment, the Engineer shall decide on a safe working route and safe working depth range between launch and reception pits and where possible, such details shall also be painted on the surface, along the line of the proposed bore.

7.5 With reference to trial borehole information and possibly geological survey maps the appropriate drill head should be selected to suit the anticipated ground conditions i.e. rock or clay etc. It is also important to ensure that sufficient drilling rods are available on site to match that required for the proposed bore length and also allow for any rod breakages. The drilling operation should be smooth and continuous to avoid potential jamming of the drilling string, with the potential loss of drill heads or reamers, which may otherwise have to be recovered by further excavation. - (not always easy, especially under rivers)

It is <u>not</u> recommended to cease operations for any lengthy period, whilst waiting for further equipment to be delivered on site, as ground conditions could collapse around the borehole and “seize-up” the drill.

The most suitable drill head for the circumstances shall be attached to the lead rod on the machine and secured to the rod by using the appropriate tooling as supplied by the drilling rig manufacturer.

7.6 The setting-up, anchorage, operation and maintenance of the HDD machine shall be in accordance with the manufacturers operational manuals and instructions.

Before propelling augured anchors attached to the drilling rig into the ground, due consideration will apply to the site specific risk assessment to ensure safety of operatives and avoid damage to underground apparatus.

7.7 The Sub-Site Locator should be calibrated in accordance with its operational instructions and the “sonde”, which is located in the drill head shall be checked for wear and that all batteries are fully charged.

7.8. The drilling machine operator, will then drill into the launch pit at a calculated degree angle in order to obtain the depths as required and agreed with the Engineer.

7.9 As the drill proceeds, bentonite or similar drilling fluid will be pumped down the drill rods, to enable the annulus that will be created to be held open and also provide a means of being able to remove the drill cuttings, which will be carried back to the launch pit.

7.10 After the second rod has been drilled into the ground, the operative who is fully trained in using the Sub-Site Locator system will locate the head to ensure both the locator and the drill head are correctly calibrated, and will then take both depth and angle readings. These will then be sent back to the rig by remote radio signal using headset receivers and transmitters so that the drilling rig operator will be able to adjust the drilling head to the required angle. Readings shall be recorded by at least every 5 metres or less and continually passed back to the machine operator in order to make any required course correction adjustments.

7.11 The drill string will eventually enter the reception pit, where the operatives will carefully remove the drilling head with the appropriate tooling and proceed to place a suitable reamer on the drill string. This will enable the annulus to be cut to the required size. The reamer will then be reversed on the end of the drill string back towards the launch pit until the appropriate size bore is cut to accept the product pipe.

7,12 After pre-reaming has taken place the drill string/reamer will be drilled through the borehole again. The product pipe will then be attached to the end of the drill string via a set of chains and a swivel and a PE pipe towing head securely screwed into the leading end of the PE pipe string.

7.13 The operatives will pump the required volume of bentonite through the centre of the drill rods and reamer and through a number of jets, thus creating a mud cake in the borehole. This will surround the duct and fill any voids created by the drilling process, whilst the PE pipe is pulled back through the borehole.

7.14 After the product PE pipe has been successfully pulled through the borehole, the operatives will remove the towing head and reamer from the rods.

7.15 Care shall be taken to prevent the ingress of drilling fluid into the newly installed PE pipe, by using pipe stoppers, whilst the launch and reception pits are cleaned out of surplus spoil, drill cuttings and bentonite slurry. If any slurry or debris accidentally enters the pipe, it must be cleaned out as soon as possible by wet swab pigging or other suitable means as determined by the Engineer.

8. TESTING, CONNECTIONS AND COMMISSIONING

These shall be carried out in accordance with those procedures designated for this purpose.