

**Κώδικας Πρακτικής για την αντικατάσταση κύριων
αγωγών με τη μέθοδο της swagelining / close - fit**

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CODE OF PRACTICE FOR MAINS REPLACEMENT- Swagelining/ Close- Fit (PE. PIPE)

1. SCOPE

This Code of Practice is intended for guidance by Engineers or their representatives responsible for the replacement of existing mains by Swagelining 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

3.1 General

The most cost effective method of replacement is by PE (polyethylene) pipe mains insertion, however this has the disadvantage of considerably reducing the carrying capacity of the main being lined. Swagelining, close-fit or die drawn as this technique is commonly known, overcomes this problem, and tests have proved that about 94% of the original capacity of the existing main is retained. The process achieves diameter reduction by pulling the lining through a reduction die. The diameter of the PE pipe is reduced by 6% and increases its lengths by 4%, with no decrease in wall thickness. The winch tension which is applied to the liner, maintains the reduced diameter and enables it to be drawn into the existing main. When the liner is installed, the winch tension is released and the liner reverts to its original size to form a close fit.

Access is required at 150 metre intervals for small bore pipelines, 300 metres for larger bores, and preferably at bends, mains connections or valve positions. The pipeline is then inspected by CCTV (Closed Circuit TV) camera and details of all service connections and junctions logged.

The liner is available in both medium and high density polyethylene pipe with various wall thicknesses to meet pressure requirements. The pipe is supplied coiled or in straight lengths, butt welded on site to form a continuous length. Monitoring of the stress on the PE pipe is undertaken throughout the insertion process to ensure safe working within design criteria. Insertion lengths can be in excess of 600 metres but will vary depending upon the diameter, curvature of the main and thickness of the pipe. Swagelining can be undertaken either hot or cold, in the pipe diameter range 75mm to 600mm.

3.2 Cold swagelining

Cold swagelining is the process of pulling the pipe using a specially fabricated four leaf nose cone pulling head, butt fused to the end of the PE pipe through a die at ambient temperature to reduce its diameter sufficiently to permit its entry into the main to be lined.

3.3 Hot Swagelining

Hot swagelining is a process similar to cold swaging with the addition of pre-heating the PE pipe to a temperature of no greater than 70°C before entry into the die. Hot swagelining reduces towing loads.

4. SELECTION CRITERIA

4.1 Close-fit linings may be installed in various pipe materials (e.g. pit cast iron, spun iron, ductile iron, steel) provided that the original pipe is circular.

4.2 Pipe sizes up to and including 24 in. (600 mm) may be considered for replacement using the swagelining technique.

4.3 The PE liner pipe should have an original diameter slightly larger than the bore of the pipe to be lined in order to obtain a close fit. Both standard and non-standard PE pipe sizes may be used (see Table 1)

4.4 the wall thickness of the PE lining should be minimised to maximise the carrying capacity of the main. Where coiled pipe or saddle fusion joints are used, particularly in smaller pipe sizes, thicker wall pipe may be necessary.

5. SITE INVESTIGATION

5.1 Maximum use should be made of all available records. Details of material types together with the position of existing valves, plugs, bends, tees, condensate receivers, change and double collars, service connections or any other obstructions in the main should be obtained.

5.2 Details of other utilities plant must be obtained and both electricity cables and telephone ducts should be physically marked out on site.

5.3 Route inspection together with on site marking-out of the main and any recorded features should take place to assist with the validation of recorded information.

5.4 Following isolation and purging of the main, the bore should be checked at the access points and recorded. It should be noted that the internal bore of each cast iron pipe may vary along its length.

6. CLOSED CIRCUIT TELEVISION SURVEY AND MAINS CLEANING

6.1 It is essential prior to close-fit lining that the main is inspected by a CCTV camera to confirm that there are no unrecorded features and also that all debris has been removed.

6.2 Where appropriate, excavations that are required for the removal of obstructions and for the CCTV survey and mains cleaning operations should be utilised as access points

6.3 From any excavation it may be possible to survey up to 600 m of isolated main (300 m in each direction), depending upon the size of the main.

6.4 Following the CCTV survey, further mains cleaning may be required together with the removal of any obstructions which have been located during the survey.

6.5 Consideration should be given to sections of main in which gas conditioning agents may collect.

6.6 All CCTV surveys undertaken should be recorded on videotape.

6.7 Various methods of pipe cleaning may be employed. Rack-feed borers, scrapers and wire brushes used in conjunction with rubber pull throughs and a winch are usually sufficient, except where heavy encrustations are encountered. Consideration should also be given to the use of a vacuum unit for cleaning pipes having dry deposits.

6.8 Whatever method of cleaning is used, it is advisable that a further CCTV survey is undertaken to confirm that all debris has been removed from the pipe, and that the cleaning operation has been successful.

6.9 After cleaning, a towing cable should be installed in the pipe in preparation for the gauging operation.

6.10 All obstructions shall be removed prior to the close-fit lining operation and, in the case of bends and condensate receivers, an additional metre of pipe on either side of the obstruction should be removed.

6.11 Any solid or liquid material found within the main shall be regarded as potentially hazardous and shall be removed and disposed of in accordance with safe working practices and any appropriate legislation.

7. GAUGING PIGS, DIE SIZING AND ROLLER SETTINGS

7.1 Following completion of the CCTV survey and cleaning operation, the internal bore of the main should be sized using a suitable steel or PE gauging pig. A typical gauging pig is shown in Figure 1. This should establish the minimum bore of the pipe to be lined and also highlight any internal obstructions which may not be evident from the CCTV survey or from access points.

7.2 When sizing the internal bore of the main to be lined, the gauging pig should preferably be pulled through by hand in each direction. When pulling the gauging pig through using a winch, the pulling force should be closely monitored and recorded.

If the gauging pig cannot be pulled through, the, depending upon the type of obstruction, the responsible Engineer shall decide whether to resort to smaller gauging pig or remove the obstruction.

If the smaller gauging pig cannot be pulled through and the obstruction cannot be removed, the responsible Engineer should consider using an alternative method of replacement.

7.3 The gauging pig should be long enough (i.e. at least 3D) to prove the bore.

7.4 Upon completion of the pipe sizing operation, the required die size should be selected from the standard range of swage die sizes provided for each nominal bore of pipe given in Table 1. Any departure from the die size or specialist die design may have a deleterious effect on the process. Where the lower sized gauging pig has been used, the lower die size must also be used.

8. LOCATION OF LAUNCH AND RECEPTION PITS

8.1 Depending upon the results of the initial site survey and CCTV investigation, launch and reception pits may be constructed. Consideration should be given to re-using CCTV survey pits as launch/reception pits.

8.2 The size all launch/reception pits and lead-in trenches should be kept to a minimum, consistent with PE pipe diameter and depth of cover.

8.3 Consideration should be given to the string of the PE pipe and location of pits, which may affect access to local premises, inconvenience to the public and cost. This may ultimately affect the maximum pulling length available unless the process can be halted to allow additional liner pipe lengths to be fused on. A profiled pipe entry roller of appropriate size used in a horizontal position shall facilitate entry of the PE pipe into the host main.

8.4 Every attempt should be made to maximise the pulling length consistent with site constraints. In cases where there are a number of deflected joints, the maximum pulling length may need to be reduced.

8.5 Linner pipe may be pulled through pits where long radius bends of up to 22.5° have been removed, provided a suitable length of the existing pipe is removed to allow for the increased radius required by the PE pipe. Where bends in excess of this have been removed, separate pulling sections are necessary and a new fitting required.

9. POSITIONING AND ANCHORING OF EQUIPMENT

9.1 Above ground, the close-fit lining rig shall be securely anchored and positioned either horizontally or inclined. Where practicable, the die unit shall be placed below ground secured to the entry of the existing main. The die end of the close-fit lining rig should be lined up with the main in a slit trench and suitably strutted. In soft ground, sheet piling or concrete thrust blocks may be necessary. For further details of the position of the close fit lining rig, see Figure 2.

CAUTION – The following method of anchoring shall not be used on a live gas main.

In unstable ground conditions, it is possible to provide an alternative form of anchoring by exposing a section of isolated main at the rear of the close-fit lining rig and then attaching anchor chains directly from the exposed section of main to the close-fit lining rig.

9.2 The cold swagelining rig, which internally reacts all resultant forces, is positioned directly on the end of the host main to be swaged (See Figure 2c).

CAUTION – Where the host main is in poor condition, additional thrust restraint should be used or may be required.

9.3 The use of a hydraulic pushing machine enables greater lengths to be achieved and also considerably reduces the winch force required. When a hydraulic pushing machine is used, it shall be secured and not left free standing.

10. TOWING HEAD TYPES

Different towing heads are required for each pipe diameter and wall thickness. All towing heads and connecting shackles shall be clearly marked with their safe working load (SWL). Examples of towing head designs are shown in Fig 3 to 6 inclusive. Towing heads are suitable for repeated use, but damaged or worn towing heads should not be used.

A minimum safety factor of 2.1 should be applied for all horizontal winching operations.

11. INSPECTION AND TESTING

11.1 All external beads of the butt fusions shall be removed and inspected prior to insertion. The internal beads of butt fusions of PE pipe sticks shall be removed prior to insertion.

11.2 PE pipe strings shall be visually inspected for damage. Any damage to the pipe wall which reduces the wall thickness by more than 10% shall be removed.

11.3 Before use, the PE pipe string shall be tested to 100 mbar for 10 minutes during which time appropriate safety precautions shall be taken and a test certificate issued on completion.

11.4 All close-fit lined sections shall be tested in accordance with the operational procedure for testing and a test certificate shall be issued.

In the case of mains operating at pressures in the range of 2 bar to 7bar, with higher test pressures applied, a settling period of 24 hours shall elapse prior to the initial test reading being taken.

11.5 If the hot swagelining process is interrupted, the close-fit lined sections shall have their internal bore proved using a suitable gauging or inflatable pig prior to commissioning of that lined section.

12. SAFETY

12.1 Close-fit lining involves the use of winching equipment. The following basic essential precautions shall be taken:

a) The Engineer shall ensure that all equipment is of suitable construction for its duty and is in good condition. Those who operate the equipment shall be adequately trained.

b) The rig, winch, lifting and towing equipment (e.g. cable, rope) shall be visually inspected for damage and wear prior to use.

c) Shackles, chains, lifting slings and towing eyes shall be clearly stamped with SWL details, and test certificates shall be available upon request.

d) The close-fit lining rig shall be of adequate design to withstand the forces likely to be imposed during operation. It shall be proof tested and labelled with its SWL.

e) The winching equipment shall be fitted with a calibrated load indicator.

Only purpose built winching equipment shall be used for any winching operation.

f) The winch unit shall be fitted with an automatic safety override to ensure that the maximum pulling force cannot be exceeded.

12.2 Where practicable, the winch load shall be reacted against the outlet end of the existing main, and all cables/ropes under tension shall be below ground or constrained. The length of exposed cable or rope under tension shall be kept to a minimum and contained or constrained against breakage. Care shall be taken when the PE is finally pulled through the die as reversion and sudden release takes place.

Adequate precautions shall be taken to ensure that all personnel are protected from the length of exposed cable or rope under tension.

12.3 Anchorage should be provided to prevent unexpected movement whilst a pipe string is set out on rollers.

12.4 Further information concerning the safety of winching operations shall be observed as detailed in Appendix B of the operational procedure for mains insertion.

13. SWAGELINING/ CLOSE-FIT LINING INSTALLATION OPERATION

The swagelining operation is described in detail in Part B Installation procedure for operational personnel.

14. BUTT FUSION PROCEDURES

It should be noted that special welding techniques are required for the jointing of thin walled PE pipe normally used for close-fit linings (See operational procedure designated for this purpose)