Code of Practice

Upstream Polyethylene Gathering Networks – CSG Industry

Version 4

Companion Paper CP-05-002

Ploughing

Rev 0

May 2017

Important note on use of the *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*.

This Code of Practice has been developed for the use of organisations involved in the CSG industry, primarily in Australia and New Zealand.

Contents

Acknowledgements

This Companion Paper has been prepared by the Australian Pipelines and Gas Association (APGA) CSG Committee working group. The working group members contributed significant time and resources at the working group level in developing and reviewing this companion paper and their support is acknowledged.

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Preface

Companion Papers have been developed by the Working Group responsible for the *APGA Code of Practice for Upstream PE Gathering Networks – CSG Industry* (the Code) as a means to document technical information, procedures and guidelines for good industry practice in the coal seam gas (CSG) industry.

Since 2008, the development of the LNG export industry based in Gladstone, Queensland, with its related requirement for a large upstream CSG supply network of pipelines and related facilities presented the impetus for significant improvements in design and best practice approach.

The principal motivation for the initial development of the APGA Code of Practice was safety and standardisation in design and procedures and to provide guidance to ensure that as low as reasonably practicable (ALARP) risk-based requirements were available to the whole CSG industry. Accordingly, the Code is focused solely on this industry and the gathering networks using locally-manufactured PE100 pipeline. The Code is a statutory document within Queensland.

The incorporation of Companion Papers in Version 4 of the Code is intended to provide information and best practice guidelines to the Industry, allowing the Code to be limited to mandating essential safety, design, construction and operation philosophies and practices.

These documents form part of the suite of documents together with the Code and are intended to:

a) be used in the design, construction and operation of upstream PE gathering networks
b) provide an authoritative source of important principles and practical guidelines for use by responsible and competent persons or organisations.

These documents should be read in conjunction with the requirements of the Code to ensure sound principles and practices are followed. These documents do not supersede or take precedence over any of the requirements of the Code.

A key role of the Companion Papers is to provide the flexibility to incorporate endorsed industry practices and emerging technologies expeditiously, as/when necessary.

A related benefit is that the Companion Papers can be referenced by the wider resources industry which uses similar PE gathering networks for gas or water handling, including coal bed methane (CBM) in underground coal mines; mine de-watering; or the emerging biogas industries (agricultural, landfill, etc.).

1 Scope

The scope of this Companion Paper is related to the safe and efficient installation of ploughing construction, and should be considered as supplementary to Section 5.3.2 of the Code, 'Ploughing'.

Ploughing has become more common and accepted in industry especially over the past five years during the expansion of the CSG industry. This installation method provides numerous construction advantages especially where high production and or sensitive considerations are key drivers.

There is minimal printed information available related specifically to ploughing installation of PE pipelines, and it is expected this Companion Paper will assist in demonstrating installation efficiency and foster greater acceptance.

2 Introduction

During recent decades, ploughing technology has emerged internationally as one of the preferred installation techniques for cable and pipe installation for a variety of flexible piping types, especially in challenging terrains. The Fockersperger Plough technology developed in Germany has spread in usage throughout the Americas, Asia and Australia. Several construction companies in Australia were using these ploughs on water and gas projects prior to 2008, up to diameters of DN 200. The technology has been used on export LNG projects with more than 2700km of PE pipe being laid, in addition to more than 1000km of electrical and fibre-optic cable.

Ploughing now represents an alternative to conventional trenching methodology for PE pipe, with the following identified advantages:

- Open excavation is reduced by 90 per cent thereby reducing trench fall-in risks to wildlife.
- Lifting and handling after completion of pipe stringing and welding is reduced.
- Construction right of way (CROW) widths can be marginally reduced as there is no requirement for excavated topsoil/ sub-strata to be stockpiled and segregated, delivering a significant advantage in environmentally or agriculturally sensitive areas.
- Minimal soil inversion / topsoil displacement – a principal advantage in cultivated paddocks (e.g. laser-levelled grain and cotton fields).
- Overall less plant and equipment is used per unit length of installed pipe, thus reducing the quantum of the overall driving task.

Potential disadvantages are few, but do include:

- Potential for mechanical damage due to unseen rock.
- Soil cracking with potential to affect overland flow.

The disadvantages are trivial, compared to the advantages.

2.1 History

The ploughed installation of pipe in Australia, especially in the recent period from 2011 to present, has used technology developed predominantly by the German company Foeckersperger.

This technology was originally modified from agricultural equipment in 1958, with the addition of cable pulling techniques to traditional agricultural ploughs used primarily for laying water pipes. Developments were made to this plough technology through the 1960s with the creation of the FWF 20 winch vehicle and the FSP 3 laying plough and subsequently the use of the technology to install power and telecommunication cables throughout Germany.

Further advancements through steel and design improvements continued through the decades and market advancements were made across Europe with the progressive winch and plough models. Notably, the development of the FWF 71 tracked winch vehicle in 1999 was a key advancement which allowed for much greater pulling power of up to 70 tonnes and increased site accessibility. This was subsequently followed by the development of the FSP 200 Plough which introduced improved control mechanisms through fully electronic controls.

The current development of this technology has extended to the FSP 280 Plough and the FWF 92 Tracked Winch Vehicle which provides 90 tonne of pulling pressure.

This technology was used to varying degrees in Australia for cable installation, though it was the modification of the technology to suit the coal seam gas industry in Queensland in approximately 2010 which led to a much greater use of the technology and realisation of its associated benefits.

Construction contractors evolved plough to accommodate larger pipe installations using numerous patented innovative techniques to install PE 100 pipe in the following configurations:

- Twin or single DN 315 pipe, plus marker tape.
- Twin or single DN 450 pipe, plus marker tape.
- Single DN 630 pipe, plus marker tape.

Third-party accreditation and testing confirmed that the design factor for installation (f2) was able to match that of the open trench method, subject to approved methodologies and controls, details of which are summarised in this paper.

3 Guidelines

Ploughing provides a realistic alternative to conventional trenching for most PE 100 pipe sizes used in the CSG industry.

The use of this technology can provide safety, environmental and production advantages (especially with straight runs) when used by competent operators with correct procedures and processes.

The following parts of this companion paper serve to provide more details around these points, though any selection or use of this technology must be, properly considered as per any other construction technique, undergo proper identification of all potentially risks / hazards, and require implementation of all necessary control measures to achieve ALARP.

3.1 Selection criteria

As per any installation technique, its applicability is subject to terrain, geotechnical conditions, project size and other factors detailed below should be considered and risk assessed.

The main points for consideration when assessing the suitability of the plough method have been listed and expanded upon in the following sections.

3.1.1 Geology / soil type / topography

An assessment of the ground conditions should be undertaken, using a cost-effective technique that provides regular assessment of field ground conditions, typically completed by test pits or ground radar.

Plough technology can be used efficiently in all ground conditions except in areas where large sections of rock layers exist. In areas where small sections of rock exist these are able to be pre-treated with dozers or conventional plant. Where rocky ground exists it is recommended that the potential for mechanical damage be considered and sample sections of ploughed pipe examined.

3.1.2 Existing services

The presence of existing services must be understood to allow for consideration of the risks and hazards associated with working in proximity to existing services.

Task specific permit to works need to include the risks associated with these services and nominate appropriate controls. Different asset owners / services will require different separation distances and these will also vary dependent upon the control measures used.

3.1.3 Productivity and efficiency requirements

Plough technology, depending on terrain and whether there are straight runs, can potentially offer significant production and associated cost efficiency to projects with daily production rates of over 2500m for dual 315 pipes with slight variances for other sizes and combinations.

3.1.4 Land holder / environmental sensitivity

Where projects are required to operate within either environmental or land holder sensitive areas, a reduced right of way width is possible, while still enabling the plough to work safely and efficiently within widths reduced down to 10–15m depending upon pipe sizes and configurations.

3.1.5 Facility installation

Pipeline facilities cannot be completed ahead of the plough installation though where ground conditions permit pre-excavated facility pits or similar can be used dependent on pipe and facility installation timeframes.

3.1.6 Over-head clearance

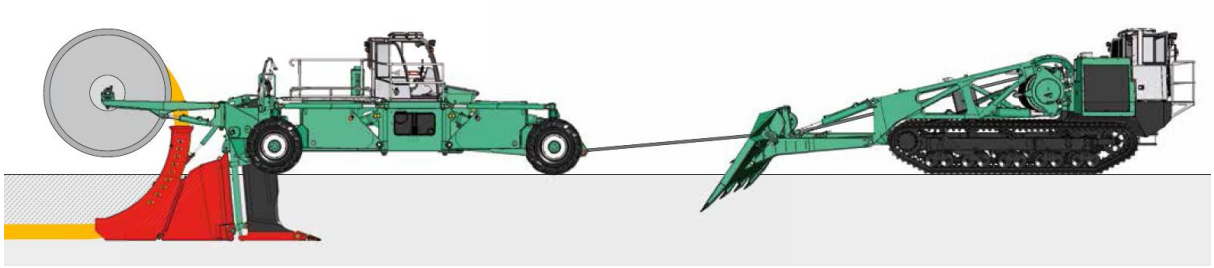
Dependent on the overhead clearance available, different plough selections (over cab or conventional) must be considered during the project planning phases.

3.2 Training

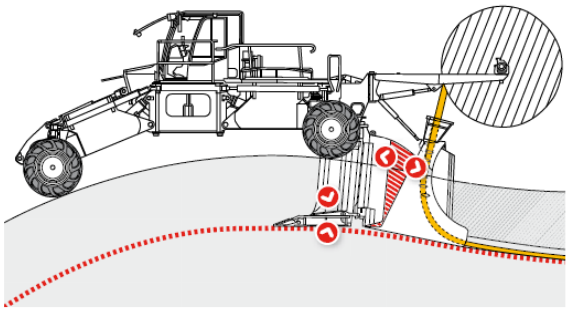
Ploughing is a specialised construction methodology and requires skilled operators. APGA has developed a specific competency standard for pipeline engineers on plough-in (PP019 Plough-in: design and construction) for this operation. Pipeline engineers proposing to consider using ploughing technology are recommended to undertake this training prior to undertaking ploughing design and engaging with specialist ploughing contractors to undertake field activities.

4 Ploughing operations

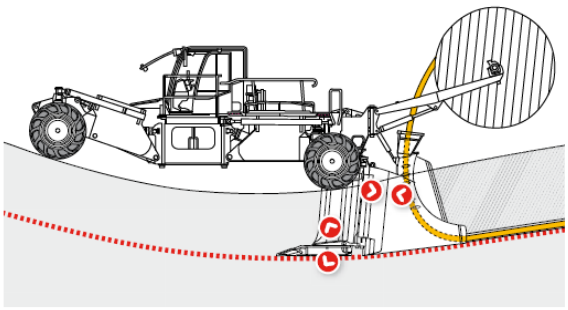
The ploughed installation process is relatively simply with a plough chute (indicated below in red) attached to a plough which is pulled forward by a winch vehicle or truck following the design alignment which is pre-loaded into the machine guidance system.



The winch vehicle anchors itself to the ground with it rear stabiliser plate and pulls the plough forward with a constant force of up to 180 tonnes per winch (with double cable). The depth and alignment of the pipe is controlled by the ripper shoe at the front of the chute which can be adjusted from the drivers cab. This enables precision pipe or cable installation in undulated slope conditions with a horizontal bend radius of up to 4m.



Laying over a hilltop



Laying in a dip

Dependent upon the project requirements, rehabilitation will be required to be completed to the trench line undertaking compaction of the disturbed trench line.

4.1 Multiple pipe installation

The installation of pipe or cable by ploughing can be configured by modification of the chute to allow for multiple cables, pipes, marker tape, tracer wire and or a combination to be installed at the same time to suit individual project requirements.

Modification of approved installation techniques should be designed / reviewed / certified by a third-party verification and certification process.

Current installation combinations have included:

- Single pipe installation (with or without tracer wire / marker tape): ranging from 110 – 630mm in diameter.
- Dual pipe installation side by side with nominated separation as determined by project requirements (with or without tracer wire / marker tape); in the following configurations DN 110, 110/160, 315.
- Various sizes and configurations of cables: not relevant under this Companion Paper.

Careful consideration must be made to the arrangement of the pipe and other materials to be installed to ensure a safe installation process that does not damage the integrity of the final product.

5 Installation process

After the right of way has been cleared and graded and the pipe has been strung, welded, and destructive testing cut outs completed, the pipe installation crew will commence the installation of the pipeline. Buried services shall be located and identified prior to commencement of any excavation works.

Similar to conventional installation methodologies the installation of polyethylene pipe by ploughing method can be broken into four main stages:

1. Ground Assessment / pre-treatment.

2. Pit excavation.

3. Ploughing of polyethylene pipe.

4. Backfill / treatment of disturbed soil.

5.1 Ground assessment / pre-treatment

Prior to undertaking plough installation an assessment of ground conditions using either potholing, ground penetrating radar or geotechnical information should be undertaken.

If this assessment determines that treatment of the ground is required due to the presence of rock or tight ground conditions, machines will be mobilised ahead of the ploughing operation to pre-treat all identified ground. Depending on the ground conditions rock will be removed by either trenching machine or excavator fitted with hydraulic rock hammer.

This ground should be treated to a width sufficient for the plough (typically 950mm) and at a depth greater than the invert of the pipe by a minimum 200mm.

5.2 Pit excavation

A 20 tonne excavator or greater should be used to excavate the plough start pit and then proceed to excavate all pits necessary for facilities installation (if ground conditions allow) followed by the exit pit.

These pits will be excavated in advance of plough and will have benches, pre-fabricated steps or ramps installed for access and then signage and barricading erected around them in accordance with project and legislative requirements.

Task specific SWMS shall be developed and address controls to prevent inadvertent contact with underground /aboveground services and other identified hazards associated with these tasks.

5.3 Ploughing of polyethylene pipe

5.3.1 Pre installation

Prior to ploughing in a string of pipe a number of pre-installation checks should be undertaken. Some of these have been listed below:

- Pipe inspected for damage.
- All welds located by survey.
- Welds inspected.
- Applicable weld test reports (destructive testing) received confirming conformance.
- All known services have been located.
- Excavation permit is completed.
- Permit to work in place.
- Cut off pipe measured by surveyor.

5.3.2 Machine control / as building

For the completeness and accuracy of plough installation ‘As building’ records should be completed using the assistance of survey machine guidance and quality verification capabilities.

This information should be correlated with the design survey data to not only ensure the location of the pipe is as per project specification requirement, but also the location and identification of each weld (if required).

5.3.3 Prior to ploughing operations

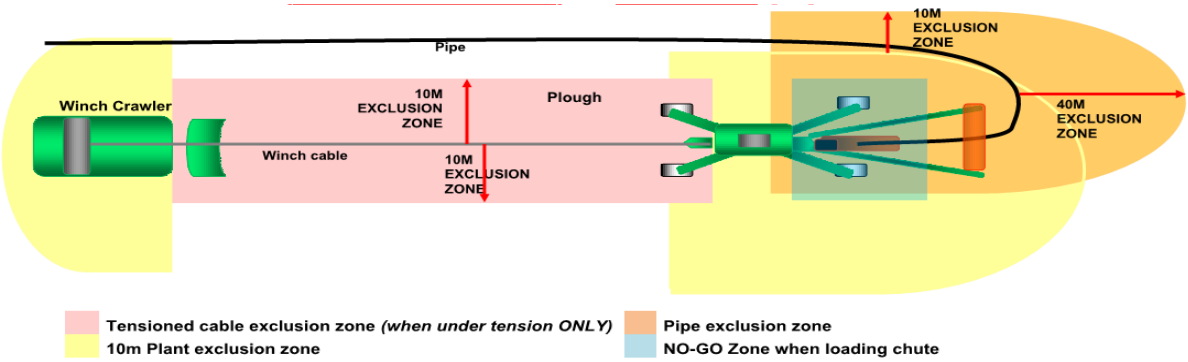
Ploughing in the vicinity of existing pipelines, cables or other services (including buried and above ground services) shall require specific safety considerations. These should be documented and approved prior to commencing plough works.

The alignment and depth of such underground services will be located prior to the commencement of the trenching works and uploaded into the site survey file. The plough will operate to typically within 50m of known services or as specified by the permit. The 50m approach will be applicable in the case of track/road crossings.

An assessment shall determine if either one or two winch crawlers will be used to pull the plough. This will depend on the job type (dual or single pipe lay), specification and ground conditions.

All plant used in the ploughing operation will have a ultra high frequency (UHF) Radio and the operators will be in contact with each other in order to coordinate the ploughing effectively and safely.

Due to the stored energy retained in the winch cables as part of the ploughing process exclusion zones must form part of any ploughing operation. A typical exclusion zone arrangement for convention ploughing is included below.



The pipe (following the completion of all pre-installation checks) will be loaded into the pipe chute with the plough positioned within the pre excavated pit and exclusion zones in place. Prior to the commencing of ploughing operations other cables (i.e. tracer wire / fibre optic) should be installed into the plough chute.

The plough should then be connected to the winch crawlers and once the winch crawler has tracked forward the specified distance, the blade should be lowered into the ground in order to stabilise the machine. At this point the operators of all machines communicate via UHF to ensure that they are all in position and ready to start ploughing the pipe into the ground. Once positions and machine status has been confirmed the plough operator shall control the activity.

The plough operator shall inform winch crawler operators via UHF to start winching. The winch crawler starts winding in the winch and pulling the plough forward and a ripper and chute displaces the soil, and guides the pipe into the trench. Once the winch is completely wound in, the winch crawler lifts the blade, tracks forward, lowers the blade and recommences winching.

This process is then repeated until the nominated plough string is completed and the pipe will be run through into a pre-excavated exit pit or by rising the pipe to the surface for future connections as determined by project requirements.

Note: Any persons working on plant and equipment must be trained in its use and a rescue plan / emergency procedure should be in place.

5.4 Backfill / treatment of disturbed soil

Once the pipe has been installed using plough methodology further treatment works are required to minimise subsidence of the trench line as much as practical. These works will be different for each project and soil conditions though will typically comprise of a grader removing a certain portion of the material and compacting, prior to the installation of marker tape at the specified depth.

The compaction works can be completed by grader tyre or other compaction equipment completing a sufficient number of passes to achieve the required soil compaction.

Following the success installation of the pipe additional connection works may be required which are covered separately under Section 5.3.4 of the Code of Practice.

6 Summary

The installation of PE100 pipe with the use of a ploughing system can offer significant safety, environmental, social and cost benefits to any project when suitably trained personnel using the latest technology, are combined with correct planning and preparation practices.

The considerations and work practices outlined within this companion paper should form part of any decision or work process involving this installation technique.

Other commercially confidential documentation e.g. work method statements are available from specialised contractors, fully compatible with CSG OPCO safe systems of work requirements.

7 References

The following Companion Papers should be referenced, as required, to optimise the use of this paper.

CP-02-001	Competency
CP-05-001	Safety in Construction
CP-11-004	Safety in Operations