

1. Introduction

This bulletin addresses the use of Flexpipe (FP150, FP301, and FP601), Flexpipe High Temperature (FP301HT and FP601HT) and Flexcord (FC901) products in liner pulls. Flexpipe products can be pulled through bores, conduit, or casing. Please refer to the Flexpipe Installation Guide for additional considerations and guidance.

2. Operational Considerations

For liner pull applications, multiple influencing factors can affect the pipeline performance and should be considered when planning the installation. Severe slugging, water hammer, high fluid velocities, impact forces, muskeg or swamp soil conditions, and thermal expansion should all be considered.

- Emulsion pipelines that are prone to severe slugging can lead to impact forces at changes in direction (e.g., riser and pipeline bends) and misaligned transitions.
- High velocities (i.e., more than 1.5 m/s (5 ft/s)) can lead to significant fluid impact forces at changes in direction and water hammer during pump start/stops. Significant impact forces may lead to damaging the pipeline.
- For operating temperatures above 30°C (86°F), thermal expansion can create additional changes in direction or bends in the pipeline (snaking or lateral movement). Thermal expansion will be uncontrolled when there is inadequate restraint at pipeline transitions and can lead to damaging the pipeline.
- Muskeg or swamp conditions may not provide the same amount of restraint as in other soil conditions due to the low soil modulus of the backfill material. Preventing operating conditions that may lead to impact forces and impingement at transitions are more critical in muskeg conditions. Bell holes and risers with muskeg or swamp conditions typically require additional restraint to prevent floatation and movement of the pipeline.
- Unburied sections of the pipeline entering or exiting the casing will not provide the same restraint as buried sections.

Proper support and restraint is required to limit movement of the pipeline due to the above influencing factors.

It is strongly recommended to limit the liquid velocity to a maximum of 1.5 m/s (5 ft/s), and the installation must provide adequate restraint at bell holes and riser transitions. Additional information on restraint is available in the 'Pipe Restraint in Transitions' section below. Typically, Flexpipe does not recommend exceeding a liquid velocity of 30 m/s (10 ft/s).

3. Conduit (and Casing) Compatibility

A conduit is an existing pipeline that has previously been in service, where a Flexpipe Spoolable Product can be pulled through as a remedial line or as a free-standing liner. A casing is a pipe that is used in crossings to protect buried Flexpipe Spoolable Products against external loads.

For liner pull applications, there must be adequate clearance between the outer diameter of the Flexpipe Spoolable Product and the inner diameter of the conduit. There cannot be obstructions in the existing conduit that could damage the Flexpipe Spoolable Product. The conduit must also be clean. See Table 1 below for guidance on compatibility of Flexpipe Spoolable Products with conduit sizes. This guidance assumes round Flexible Spoolable Product and a straight line pull.

Table 1: Steel Conduit Piping Compatibility Chart

N = Not compatible P = Compatible for pipe without fittings PF = Compatible for pipe with coupling fittings

Conduit Product	3" Steel		4" Steel			6" Steel				8" Steel
	0.188" wall	0.120" wall	Sch. 40	0.188" wall	0.125" wall	Sch. 80	Sch. 40	0.188" wall	0.125" wall	All wall sizes
2" FP301/HT	P	P	PF	PF	PF	PF	PF	PF	PF	PF
2" FP601/HT	N	P	PF	PF	PF	PF	PF	PF	PF	PF
3" FP150	N	N	P	P	P	PF	PF	PF	PF	PF
3" FP301/HT	N	N	N	P	P	PF	PF	PF	PF	PF
3" FP601/HT	N	N	N	N	P	PF	PF	PF	PF	PF
3" FC801/FC901	N	N	N	N	P	PF	PF	PF	PF	PF
4" FP150	N	N	N	N	N	P	PF	PF	PF	PF
4" FP301/HT	N	N	N	N	N	P	PF	PF	PF	PF
4" FP601/HT	N	N	N	N	N	P	P	PF	PF	PF
4" FC801/FC901	N	N	N	N	N	P	P	PF	PF	PF

Wall Thickness	8" Steel				10" Steel			
	Sch. 20	0.219" wall	0.188" wall	Sch. 10	0.252" wall	0.220" wall	0.189" wall	0.157" wall
Conduit ID	8.125"	8.187"	8.249"	8.329"	10.246"	10.309"	10.372"	10.435"
Product								
5" FP301 HT	PF	PF	PF	PF	PF	PF	PF	PF
5" FP601 HT	PF	PF	PF	PF	PF	PF	PF	PF
6" FP601 HT	P	P	P	P	PF	PF	PF	PF

N = Not compatible
P = Compatible for pipe without fittings
PF = Compatible for pipe with coupling fittings

Conduits limit movement which helps avoid potential kinks of Flexpipe Spoolable Products. A maximum conduit diameter of 4 times the Flexpipe Spoolable Product nominal diameter is recommended.

The maximum recommended number of Flexpipe Spoolable Products within a single conduit is 5.

Many factors can affect actual pull forces and must be evaluated by the installation contractor during project planning stages:

- Pulling ovalized pipe off the reel
- Radius of bends
- Number of bends
- Friction forces acting on the pipe during the pull
- Length of pull
- Diameter of conduit or bore

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Typically, digging a bell hole and removing the conduit is required at every bend for liner pulls. Contact Flexpipe Engineering for guidance when pulling coupling fittings through bends.

Before installation of Flexpipe Spoolable Products, a sizing plate should be run through the line. Flexpipe recommends pulling the sizing plate in the direction of the original flow of the conduit pipe. Use an appropriately sized sizing plate based on the conduit ID with consideration for the Flexpipe pipe or fitting with wrapping OD. If excessive debris is present, multiple passes may be required to ensure the conduit is clear of obstructions. This will typically be performed by the wire line truck when the cable is blown through the line. The sizing guidance in this section is general in nature. The installation contractor should evaluate each installation and select the appropriate sizing plate dimensions based on all project variables.

Before committing to pulling a section, a 10 meter (33 foot) test piece of pipe should be pulled through to ensure that the inside of the conduit is obstruction-free. If the test segment of Flexpipe Spoolable Product successfully passes through the entire conduit line without damage or without excessive pull forces, the Flexpipe Spoolable Product can be pulled into place.

4. Installation

4.1. Preparation

Extra caution should be used when the installation method does not allow the pipe to be inspected after deployment. The method used to install Flexpipe Spoolable Products is ultimately determined by the end user.

Discussions between the pipeline end user and installation contractor regarding project and installation parameters are recommended. Flexpipe recommends a Flexpipe field technician, or contractor field personnel who have been through the Flexpipe Contractor Installation Training Course, be present any time Flexpipe Spoolable Products are being handled. A survey drawing with elevation profile or a reasonably accurate hand drawn map including bends, elevations, and crossings may be sent to Flexpipe Engineering for feedback.

4.2. Pulling

If there are too many bends or crossings, a long pull might not be achievable. Bends in the conduit will increase the drag force on the pulled pipe. A site visit may be necessary to confirm pull lengths. To ensure the success of the pull, restrictions must be minimized. This must include ensuring the line is clear of wax or deposits. Pigging is highly recommended.

NOTE!



Centering guides or spacers are not required for installing Flexpipe Spoolable Products in casing or conduit pipe. Allowing the pipe to move inside the casing or conduit will accommodate pipe expansion and contraction during operation.

If pulling with an anode kit installed on coupling fittings, ensure that the anode kit is installed on the side of the coupling that will enter the conduit last, as shown below. Allow more clearance for the anode kit than what is listed in Table 1. More information on installing anode kits on fittings can be found in the Flexpipe Pipe Installation Guide.

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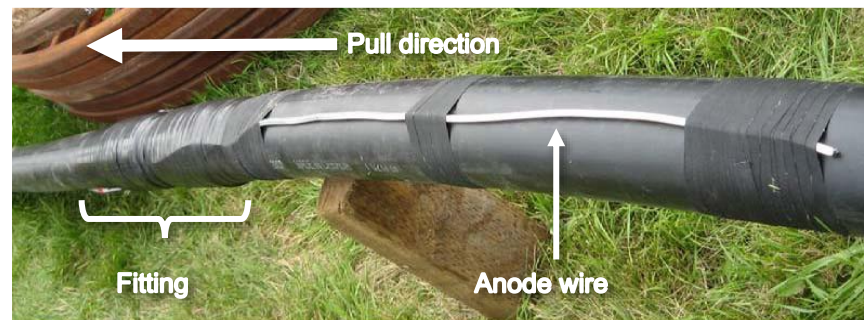


Figure 1: Anode Wire Installation Direction

It is recommended to use the Flexpipe Internal Pull Tool for pulling through conduit pipe. Proper installation of the internal pull tool is critical. Please refer to the Flexpipe Pipe Installation Guide, for details on the procedure. The boring contractor is required to wrap the pull tool with tape to prevent water from wetting the pipe fiberglass or cord reinforcements.

A swivel is also required for conduit pulls. When pulling multiple lines through a conduit, each line should have a separate swivel, and the entire assembly should have an additional swivel to help prevent lines from wrapping around each other. Detailed pull tool guidance is found in the Flexpipe Pipe Installation Guide.



Figure 2: Swivel Heads for Multiple Lines



Figure 3: Twisted Pipe Pulled Without Swivels

When pulling Flexpipe Spoolable Products, the maximum pull force shown in Table 2 must not be exceeded. The pull load applied to the pipe must be measured and recorded using an inline tensile load measuring device for all bore and conduit pulls. The values of pull force measurement obtained should be reliable and must not exceed the limits below. Flexpipe recommends pulling in the direction of the original flow in the conduit pipe. After the pull is complete, the section that was pulled on should be cut back at least 1.5 meters (5 feet) from the pull point and discarded. It is also recommended to limit the pulling duration of a single reel to a maximum of one hour.

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Table 2: Maximum Pull Force

Flexpipe NPS	Pounds (lbf)
2"	2,500
3"	4,900
4"	7,200
5"	11,250
6"	16,800

Note: The maximum pull forces are based on a pipe temperature of 23°C (73 °F) at the time of pull using an Internal Pull Tool. Contact Flexpipe Engineering to discuss maximum pull force loads for higher pipe temperature pulls.

Lubrication such as canola oil or another readily available vegetable-based oil may be used to reduce friction forces while pulling.



Figure 4: Lubrication for Liner Pull

4.3. Bell Holes

The bell holes should be dug at pre-determined locations. There will be a minimum of one bell hole at each end of the line and depending on bends/lengths possibly more in between. When possible, accurately measure the distance of the line so that reel lengths can be chosen between bell holes to minimize the number of pulls. Where fittings are to be installed, the space between the two sections of the conduit must be at least 12 meters (40 feet). This is the minimum space needed for a proper fitting installation. It is also required to leave enough spacing to allow 1 meter (3.3 ft) of straight pipe at each casing opening, and to have no bends within 1 meter (3.3 ft) of a crimp fitting.

For additional guidance on the deployment and installation of Flexpipe Spoolable Products, please refer to the Flexpipe Pipe Installation Guide.

4.4. Pipe Restraint in Transitions

Flexpipe requires terminating the liner pull underground and providing a minimum of 7 meters (23 ft) of uncased buried length before bringing the pipe to surface, as shown in Figure 5 below. This ensures any expansion or contraction concentrated inside the existing casing is restrained by ground friction before coming to surface. This is particularly important when thermal expansion is expected. For more information on thermal expansion, please see the Flexpipe Technical Manual.

At casing ends, bell holes, or when there is space between separate conduit sections, continuous support of Flexpipe Spoolable Products is required. Proper support should remove any points of impingement, should ensure the minimum bend radius of the pipe is not exceeded, and should prevent the pipe from impinging on the entrance and exit edges of casing.

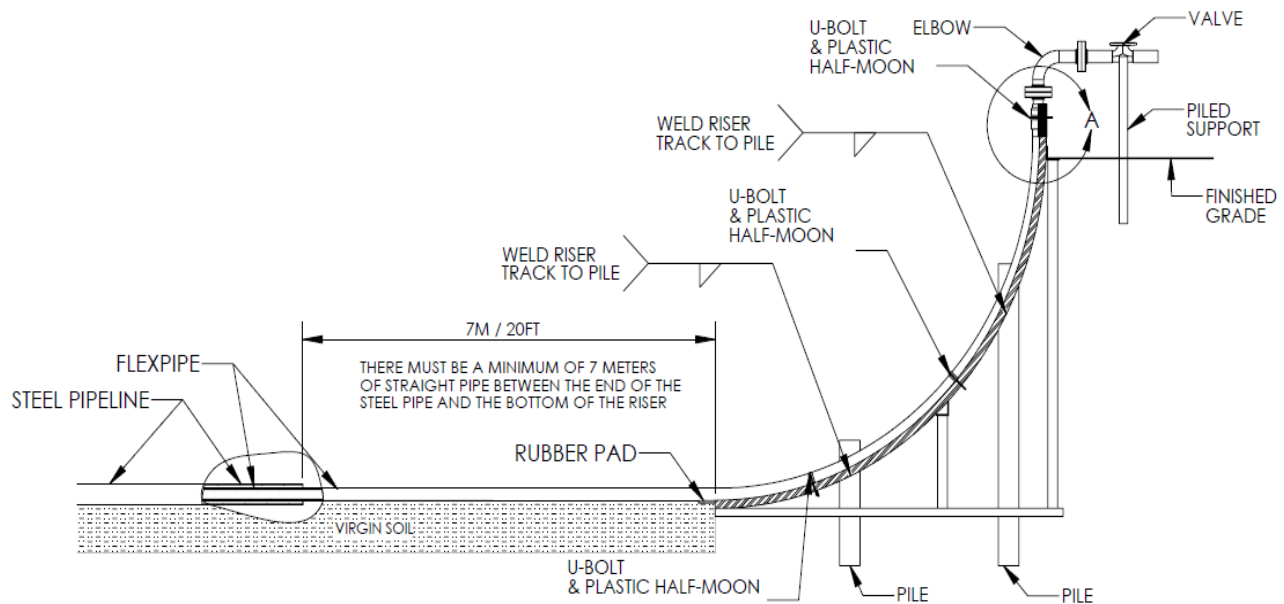


Figure 5: Liner Pull Termination With 90 Degree Riser

For continuous support, steel C-channel may be welded to the casing as seen in Figure 6 and Figure 7 below to provide a smooth transition either from casing to casing, or from casing to virgin ground.



Figure 6: C-Channel Welded to Casing Exit



Figure 7: Continuous C-Channel Support

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Proper support may also include compacted sandbagging, virgin soil, or a compacted clay or soil bed to ensure the pipe is supported. If there are still open spaces or loose sandbags, more support is required. Additional considerations for pipe support and transitions between grades or surfaces can be found in the Flexpipe Pipe Installation Guide.



Figure 8: Insufficient Sandbag Support



Figure 9: C-Channel & Sandbags Continuous Support

To control lateral movement from thermal expansion in muskeg conditions, use U-bolts or custom anchors to secure the pipe to steel channels. U-bolts should be no more than 1.5 meters (5 feet) apart. Additional guidance on the use of U-bolts for support can be found in the Flexpipe Pipe Installation Guide. The suitability of the conditions and proper support techniques may be evaluated based on existing pipelines in the area and consultation with Flexpipe Engineering.

In muskeg conditions, when additional pipe support will be needed to prevent floatation, use the weighted saddle-bag guidance provided in the Flexpipe Installation Guide. Please see the Flexpipe Technical Manual for information on pipe buoyancy, net buoyancy calculations, and recommended weights for securing pipe.



Figure 10: Custom Pipe Anchor Example



Figure 11: C-Channel Secured to Casing by U-Bolts

4.5. Casing Ends

Flexpipe recommends that a steel slip on flange is welded on each end of the existing steel casing to ensure maximum flexibility for set up during the installation process. The steel slip on flange is also recommended to protect the Flexpipe Spoolable Product. The flanges may be required for the wire line truck to attach its lubricator to the pipeline for the blow down process. An A-frame or deployment trailer should be placed so that the pipe can be deployed directly into the conduit as it is being pulled by the wire line cable.

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To protect the pipe from possible shear forces or impingement at the casing edges, rubber padding is recommended, as well as a straight section of at least 1 meter (3.3 feet) of pipe going into the casing. For conduit with a diameter significantly larger than the pipe or without an attached flange, cutting back the edges such as seen in Figure 12 may also be considered.



Figure 12: Examples of Casing Edge Protection

Compressive watertight seals such as the one shown to the right are not recommended.



Figure 13: Link-Seal at Casing End

5. Flexpipe Water Ingress Protection

It is important to ensure the jacket is free of through-wall damage, the pipe ends are adequately taped to prevent water ingress during installation, and the crimp fittings are adequately taped to prevent water ingress while in service. If the environment between the Flexpipe Spoolable Product's liner and jacket becomes wet for any reason, this will lead to a reduced product life.

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In order to prevent wetting the reinforcement layer of the pipe end during installation of the pipe, ensure protective paste is applied to the cut pipe end and that petrolatum and pipeline tapes are applied over the nut and threads of the pull tool head. It is required to follow the wrapping guidance in the Flexpipe Pipe Installation Guide to protect the pipe and fitting from water ingress. For high water table installations with water depths greater than 1 meter (3.3 feet), contact Flexpipe Engineering for additional guidance.

CONTACT US!



For any further information or consultation on a boring or conduit pull project, please contact a Field Operations representative through our toll-free number:

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