

1. Introduction

This bulletin addresses the use of Flexpipe Spoolable Products in surface pipeline applications. This bulletin is intended to be read in conjunction with the Flexpipe Technical Manual, the Flexpipe Installation Guide, and the Flexpipe Product Data Sheets.

2. Background

Flexpipe Spoolable Products are widely used for surface pipeline applications. This bulletin provides guidance to successfully complete and operate surface pipeline projects.

When a pipeline is permanently installed on the surface it is subject to expansion and contraction due to pressure and temperature fluctuations. Lateral displacement in sections of the pipeline is expected, as shown in **Figure 1**. Several considerations must be taken into account during the design, installation, and operation of this type of pipeline application.



Figure 1: Expected Lateral Displacement after Axial Expansion due to Pressure and Temperature Fluctuations

CAUTION!



By their nature, surface pipelines are installed in an uncontrolled environment and have a greater risk of external damage than buried pipelines. The operator must evaluate the potential hazards associated with the pipeline right-of-way.

3. Design

3.1. Fluid Flow Considerations

Flexpipe recommends limiting the fluid velocity of liquids to a maximum of 5 ft/s (1.5 m/s) for all installations. High velocities (e.g., more than 5 ft/s) can lead to flow-related damage due to changes in momentum, rapid starts/stops, severe slug flow, or rapid valve open/close events. If high fluid velocities are expected, appropriate precautions should be taken. Typically Flexpipe does not recommend exceeding a liquid velocity of 10 ft/s (3 m/s).

When Flexpipe products installed in surface line applications are unrestrained, the pipelines may experience undesirable pipe movement during operation.

To reduce the risk of flow related damage, it is recommended to:

- Reduce the severity of slug flow and on/off cycles in general, and
- Provide restraint by placing dirt piles or sandbags at the entry and exit areas of any pipeline change of direction, and at each fitting. Flexpipe strongly recommends using dirt piles to restrain the 164 feet (50 meters) of pipe leading directly into an end connection.

NOTE!



All restraints installed for pipe anchoring (e.g., dirt piles, sandbags) must be placed after the pressure test.



Figure 2: Sand Piles at Pipeline Entry to Facilities

3.2. Pipeline Connections to Facilities

Flexpipe Spoolable Products must be properly supported when joining to surface equipment. Methods for connecting surface pipelines to facilities include:

- Connection without a rigid pipe riser.
- Connection using a rigid pipe riser.

3.2.1. Pipeline Connections to Facilities Without Rigid Pipe Risers

When Flexpipe Spoolable Products are installed on the surface without a rigid pipe riser, the above-ground connection must be at a 45-degree angle per **Figure 3**. **Figure 4** shows an unacceptable above ground connection at a 180-degree angle. Flexpipe Spoolable Products should be supported from the ground to the connection. Refer to **Table 1** for the recommended maximum distance between pipe supports for Flexpipe Spoolable Products. If a 45-degree angle is not feasible, please contact Flexpipe Engineering for additional guidance.

Table 1: Recommended Maximum Pipe Support Spacing

Recommended Maximum Support Spacing				
Flexpipe Spoolable Product	Liquid Service		Gas Service	
	(m)	(ft)	(m)	(ft)
2"	1.1	3.5	1.2	4
3"	1.2	4	1.5	5
4"	1.5	5	1.7	5.5
5"	1.5	5	1.8	6
6"	2.4	8	2.9	9.5



Figure 3: Acceptable Surface Pipeline Connection – 45-Degree Angle to Above Ground Equipment



Figure 4: Unacceptable Above Ground Connection - Surface Pipeline Connections Must be at a 45-Degree Angle

3.2.2. Pipeline Connections to Facilities with Rigid Pipe Risers

When Flexpipe Spoolable Products are installed on the surface using a rigid pipe riser, terminate the pipeline on the surface at each end to bring the pipe to the facility. This removes a directional change within the composite pipeline (i.e., horizontal to vertical) and reduces the likelihood of damage caused by high velocity fluids. A minimum of 100 feet (30 meters) of straight Flexpipe leading in to the rigid pipe riser is strongly recommended.

3.3. Crossings

Please refer to the Flexpipe Installation Guide for general guidance on crossings.

3.3.1. Cased Crossings

A casing is a pipe that is used in crossings to protect Flexpipe Spoolable Products from external loads. Flexpipe recommends installing a maximum of five (5) lines within a single casing, as shown in **Figure 5**. This recommendation allows the pipe to rotate to a neutral position during the pressure test. The casing nominal diameter should be a maximum of four (4) times the Flexpipe Spoolable Product's nominal diameter.



Figure 5: Cased Crossings for Flexpipe Spoolable Products

3.3.2. Lines Crossing Other Lines

Pipe-on-pipe placement such as a Flexpipe Spoolable Product laying across other Flexpipe lines or across steel pipelines can result in failures due to abrasion similar to that seen in **Figure 6**.



Figure 6: Pipe Damage from Abrasion Against a Solid Surface

When Flexpipe Spoolable Products are installed on the surface, avoid unsupported line crossings over other pipelines as it increases the risk of kinking and abrasion damage. If crossing over other pipelines is necessary, the pipelines must be separated with a protective material such as sandbags or sand piles. **Figure 7** shows an example of proper sandbag placement for crossed pipelines. **Figure 8** is an example of improper placement of crossed pipelines.



Figure 7: Flexpipe Line Crossings Protected by Sandbags and Sand Piles



Figure 8: Unacceptable Unsupported Line Crossings

3.3.3. Vehicular Crossing of Surface Lines

Flexpipe does not recommend driving over Flexpipe Spoolable Products with vehicles or equipment due to potential damage to the pipe. When vehicle crossings are expected, Flexpipe products must be buried or cased.

4. Installation

Flexpipe Spoolable Products installed in surface pipeline applications are subject to expansion and contraction due to pressure and temperature fluctuations.

Operational experience has shown that unrestrained Flexpipe products installed in surface line applications may experience undesirable pipe movement during operation. Excessive pipe movement may increase the risk of damage and/or reduce the integrity of the pipe.

The installation of Flexpipe Spoolable Products in surface applications should be supervised by a Flexpipe representative or by personnel with a valid Flexpipe installation certificate with experience in Flexpipe surface line installations. The installation should comply with the following recommendations to minimize the risks associated with pipe movement during operation.

4.1. Deployment

CAUTION!



Sharp rocks or any rocks larger than 2 in. (51 mm) in diameter must be removed if protruding from the deployment area. Ensure the pipe is deployed on ground free of large rocks.

It is required to allow the end of the pipe to rotate freely during the unspooling process. This can be achieved by using a swivel link between the pipe end and the pulling equipment or anchor, as shown in **Figure 9** and **Figure 10**. If pipe sections from multiple reels will be joined together, each section must be fully strung out independently before joining.



Figure 9: Surface Pipeline Deployment Using a Swivel



Figure 10: Swivel Detail

Multiple lines of Flexpipe Spoolable Products may be installed in the same right of way. Flexpipe recommends maintaining a minimum separation distance of **4 in. (102 mm)** between pipelines in the same right of way to allow the Flexpipe Spoolable Products to rotate to a neutral position during the pressure test.



Figure 11: Recommended Separation Distance of 4 in. (102 mm) Between Surface Pipelines

For Flexpipe Spoolable Products installed in surface applications, it is recommended to remove all the slack from pipeline after deployment, as illustrated in **Figure 12**.

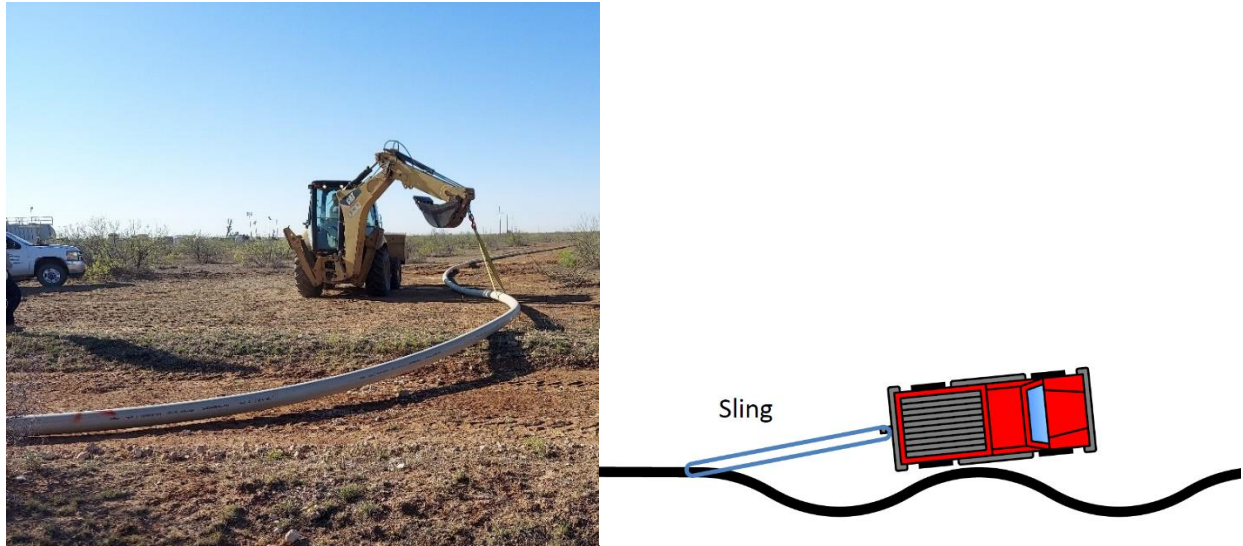


Figure 12: Pulling Out Slack from Flexpipe Spoolable Products

Avoid significant curves in the pipe except as needed to change direction using the appropriate bend radius per **Table 2**.

Table 2: Minimum Operating Bend Radius

Flexpipe Spoolable Product	Minimum Operating Bend Radius	
	(m)	(ft)
2"	1.2	4
3"	1.8	6
4"	2.1	7
5"	3.1	10
6"	3.4	11

It is recommended to inspect the pipeline and remove any rocks adjacent to the pipeline that are larger than 2 in. (51 mm) in diameter.



Figure 13: Remove any Large Rocks or Other Objects to Avoid External Damage

4.2. Fitting Installation

Only Flexpipe-approved white pipeline tape should be used on above-ground fittings to limit the effects of solar heating.

After the pressure test, all coupling fittings should be anchored by covering the pipe with dirt piles or sandbags to a depth of 4 feet (1.2 meters) over a length of 20 feet (6 meters).

4.3. Pressure Testing

Please refer to the Flexpipe Installation Guide and the Field Pressure Testing of New and Existing Pipelines Bulletin #06-4026 for guidance on pressure testing.

After joining and installing Flexpipe Spoolable Products, it is required to seal one end of the line with a blind flange and leave the end unrestrained while performing the pressure test, as shown in **Figure 14**. This allows the Flexpipe Spoolable Product to rotate to a neutral position.

It is recommended to perform a minimum of 4 hours of pressure conditioning.

For surface pipeline applications, it is good practice to allow both ends to rotate freely. Proper set up of pressure gauges to allow for pipe rotation should be considered.



Figure 14: Allow at Least One End of the Pipeline to Rotate Freely During the Pressure Test

NOTE!



Allowing at least one end of the pipe to rotate freely during the pressure test is critical to reduce the risk of forming twisted sections on surface lines.



Figure 15: The Risk of Forming Twisted Sections Increases When the Pipe is not Allowed to Rotate to a Neutral Position

Several loose slings may be used (as necessary) to limit the sideways movement of the unrestrained pipe end.

CAUTION!



Ensure all personnel maintain a safe distance during the pressure test.

The pressurization and depressurization rates should not exceed 200 psi/min (1400 kPa/min).

4.4. Pipe Anchoring After Pressure Test

After successfully completing the pressure test, it is required to secure the line along corners, bends, coupling fittings, end connections, and in long straight sections at intervals no greater than 164 feet (50 meters).



Figure 16: Anchoring the Surface Pipeline after Pressure Testing using Sand Piles

Secure the line by covering the pipe with dirt piles or sandbags to a depth of 4 feet (1.2 meters) and length of at least 20 feet (6 meters).

The dirt piles or sandbags should be placed after the pressure test to reduce the risk of pipeline twisting during flowback or during normal operation.

Closer restraint spacing may be used as deemed appropriate by field personnel to prevent pipeline movement. Where transition to trenching is used, a well-supported gradual slope should be used for trench entry and exit to avoid shear loading.



Figure 17: Pipeline Curve Covered with Sand Piles after the Pressure Test

When crossing over other pipelines is necessary, it is required to separate the pipe with a protective material such as sandbags or sand piles, as shown in **Figure 18**.



Figure 18: Separating Pipe Crossings with Protective Material such as Sandbags or Sand Piles

CAUTION!



Pipe vibration or movement on hard and rough surfaces may lead to jacket abrasion, reinforcement damage, and potential pipe rupture. Where excessive pipe movement is expected, ensure the pipe is properly restrained.

4.5. Continuous Sand Berm Installation

When a pipeline is installed with a continuous sand berm, it is required to leave a maximum of 5 feet (1.5 meters) of unburied pipe before and after each coupling fitting during the pressure test. The rest of the pipeline should be completely covered with soil or sand berms to restrain the line. In areas with loose or light soil, more material may be required to fully restrain the line.

During the pressure test, it is required to seal one end of the line with a blind flange and leave the flange and 20 feet (6 meters) of pipe unrestrained, allowing the Flexpipe Spoolable Product to freely rotate to a neutral position.

For continuous sand berm installations, it is good practice to allow both pipeline ends to rotate freely.

5. Operating Considerations

5.1. Commissioning and Flowback

Well flowback conditions (i.e., temperature, pressure, flowrates) should not exceed Flexpipe's published maximum allowable limits. Sudden temperature and pressure changes should be avoided.

5.2. Operations

Unrestrained Flexpipe Spoolable Products installed in surface line applications may experience undesirable pipe movement during operation. After the pipeline is in service, it is recommended to restrain any sections identified with excessive movement by placing additional sand piles or sandbags.

CONTACT US!



For any further information or consultation on a surface pipeline application project, please contact your Field Operations representative through our toll-free number:

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