Operations for Lay Flat Hose in Oilfield Water Applications

API Recommended Practice 15WT
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1 Scope

This document provides guidelines and establishes recommended practices for the operation of lay flat hose used for the transportation of water associated with onshore upstream oil and gas operations, in order to prevent damage of lay flat hose and damage of lay flat hose assemblies. This document includes the transportation of formation water, injection water, brackish water, fresh water, and saline.

2 Normative References

There are no normative references in this document.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1

abnormal pressure

Pressure observed within the hose assembly system that falls outside the normal operating pressure ranges.

3.2

bend radius

The minimum radius one can bend the hose without kinking it, damaging it, or shortening its life.

NOTE 1 Bend radius is recommended by the hose manufacturer and it can be dependent on hose material and maximum allowable working pressure.

NOTE 2 At maximum allowable working pressure a hose can be bent in a smaller radius without kinking than at lower pressures.

3.3

brackish water

Water with dissolved-solids concentration between 1,000 and 10,000 milligrams per liter (mg/L), however these limits can vary by jurisdiction, and local definitions supersede this definition.

3.4

catch point

A designated location where a pig will lodge or be caught after it has traveled its course and removed water from the line.

NOTE This is also known as a pig catcher.

3.5

design pressure

The maximum expected pressure the hose assembly system will be exposed to along the route.

NOTE This pressure is based on the flow rate, fluid being transported, topography, hose diameter, equipment specifications and other factors as determined by the hydraulic analysis.

3.6

design temperature

The transported fluid temperature used in the calculation of maximum allowable operating pressure and/or design pressures.

3.7

fresh water

Water with total dissolved solids below 1,000mg/l.

NOTE Local jurisdictions or regulatory bodies use varying definitions.

3.8

hose assembly

A length of lay flat hose with attached couplers on both ends of the hose.

3.9

hose assembly system

Lay flat hose inclusive of all installed pumps, valves, manifolds and other engineered components along the entire route of a water transfer operation.

3.10

hose pincher

A tool designed and used to clamp the hose to allow isolation of the hose to affect a repair, limit the size of a leak or to insert a pig.

3.11

hydraulic analysis

A detailed calculation evaluating the flow of fluid through the hose assembly system.

3.12

hydrostatic pressure

Pressure exerted by the weight of the fluid under static conditions due to the force of gravity.

3.13

jacket

The outermost part of a lay flat hose

3.14

lay flat hose

lines
A flexible conduit used for transferring fluids under pressure.

NOTE When purged and empty it is flat and can be rolled up for storage and transport.

3.15

gauge

A device used to monitor the internal line pressure, usually in pounds per square inch (psi).

3.16

Manufacturer

The party that made the hose and/or coupling.

3.17

maximum allowable operating pressure

MAOP
The maximum pressure at which a pipeline or segment of a pipeline may be normally operated as defined by the owner.

NOTE In some situations, it is equal to or less than the maximum allowable working pressure because of the fluid being transported, unique terrain, weather/environmental conditions, and/or environmental sensitivity of the area in which the lay flat hose assembly is being operated.

3.18

maximum allowable working pressure

MAWP

The maximum pressure at which a hose assembly system should be operated as defined by the manufacturer of the components of the hose assembly.

3.19

dead head pressure

The highest pressure the hose assembly system will be exposed to when a pump is operating in a blocked flow condition.

3.20

non-fresh

Any water that is not defined as being fresh water.

3.21

operating pressure

The actual pressure in the hose assembly at a given point along the route during operation.

3.22

operator

The party responsible for managing the transport of water in lay flat hose

3.23

overpressure

Pressure that exceeds a defined limit.

3.24

owner

The entity that has ultimate responsibility and liability for the facility or equipment and fluid being transported.

3.25

pig

A device, usually a cylindrical foam object, that is pushed through lay flat hose by compressed air.

3.26

pigging

The process of removing water from lay flat hose by placing a foam cylinder (pig) in the conduit and moving the pig forward to displace the water from the end of the line and into an approved storage site. (e.g. Frac tanks, AST, pit or pond)

3.27

produced water

PW
Fluid that is an incidental byproduct from drilling for or the production of oil and gas.
NOTE 1 Includes, where present, formation water, injection water, and any chemicals added downhole or during the oil/water separation process.

3.28

reinforcement

The structural support for the hose that is often in the form of woven yarn.

3.29

right of way

ROW
A strip of land, normally secured by a ROW agreement with the land owner(s), on which pipelines, railroads, power lines, roads, highways, and other similar facilities are constructed.

3.30

saline

Any water having dissolved-solids concentration greater than 10,000 mg/L.

NOTE 1 These limits vary by jurisdiction, and local definitions supersede this definition.

NOTE 2 Most produced water falls within the saline range of total dissolved solids concentrations.

3.31

ski rope

A device for pulling an empty lay flat hose.

3.32

snaking

Movement of a hose upon pressurization resulting in a deviation from the intended path.

3.33

total dissolved solids

TDS
The total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per unit volume of water (mg/L)

3.34

traceability

The ability to identify the origin of materials and parts used to manufacturer a given component; and/or the product processing or manufacturing history.

3.35

tracking

Knowing, documenting, and/or collecting information related to the distribution, location and operating history of a given component after delivery from the manufacturer or supplier.

3.36

water hammer

A pressure surge or wave caused when a fluid in motion is forced to stop or change direction suddenly; a momentum change.

NOTE A water hammer commonly occurs when a valve closes suddenly at an end of a pipeline system, including hose assembly systems, and a pressure wave propagates in the pipe.

3.37

whip check

A safety cable that connects air hoses across the coupling to prevent unrestrained, violent movement of the hose ends if the connection inadvertently separates.

3.38
water transfer
transfer
The movement of water from one location to another via lay flat hose.

4 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

AST	Above-ground Storage Tank
MAOP	Maximum Allowable Operating Pressure
MAWP	Maximum Allowable Working Pressure
mg/L	Milligrams Per Liter
PW	Produced Water
ROW	Right Of Way
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids

5 Pre-Job Planning

5.1 Risk Assessment Guidelines

Each water transfer job shall have a risk assessment in advance. The risk assessment should include at a minimum:

a) The chemicals and fluids being transported prior to each job to ensure lay flat hose and associated components are suitable for the service to which they are employed.
b) Natural and man-made hazards along route selected.
c) Hydraulics of the hose assembly system, as outlined in Section 5.6.
d) The quality and condition of the lay flat hose assembly being selected and deployed.
e) The training and qualification of operations personnel required to deploy and operate the lay flat hose assembly and associated equipment.

5.2 Route Selection General Guidelines

The operator should review the route in advance and include at a minimum:

a) Routing the hose assembly in the most direct manner possible.
b) Avoiding unnecessary elevation changes and rough terrain.
c) Avoid traversing side slopes where possible.

d) Maintaining the manufacturer's minimum bend radius
e) Minimizing road and water crossings where possible
f) Minimizing routes that traverse sensitive areas and other natural or manmade hazards that includes the impact of noise and increased traffic on the surrounding areas.
g) Impacts on localized flooding during normal and storm precipitation events if existing culverts are utilized for road crossings. The use of culverts as road crossings is acceptable, depending on the jurisdiction, however use should not unduly burden the existing drainage system
h) Necessary minimum distance from roads to prevent vehicle impact to the lay flat hose.
i) Low points in the line should be considered and evaluated to plan for how the line will be adequately drained and removed upon completion of the job as per Section 8.2.

NOTE In some jurisdictions, agreements, rights of way, notifications, and local and jurisdictional permits might be required in advance of deployment of a hose assembly system.

5.3 Road Crossings Design

The hose assembly crossing any roadway shall be installed to allow for vehicles to safely cross the hose assembly without damage or impact to the hose assembly or vehicle.

As a minimum, the road crossings design shall include the following:

a) If the road crossing restricts the flow, the hydraulic analysis shall include the impact of this flow restriction.

b) Structural strength - The road crossing should be engineered and constructed with sufficient strength to handle the expected external loads and clearance for expected crossing traffic and meet the maximum allowable operating pressure (MAOP) of the hose assembly system.

c) Placement - Road crossings near intersections and curves should provide sufficient distance, where possible, to allow roadway traffic to safely use the road crossing.

d) Existing infrastructure - Road crossings should not utilize existing culverts or cattle guards unless used to reduce impact on local roadways.

NOTE In some jurisdictions, permits might be required to utilize existing culverts or cattle guards.

e) Road crossings shall be large enough to hold the lay flat hose and fittings; and shall freely accept the entire hose width without pinching or rubbing the hose assembly.

f) Illumination - Lighting choices should be evaluated to ensure that they do not create excessive light pollution and that the chosen method does not negatively affect any light sensitive areas. (e.g. areas impacted by the Dark Skies Initiative of Texas)

5.3.1 Fabricated, low profile style

Fabricated road crossings should be engineered and fabricated to at least the same pressure rating of the hose assembly with which it will be used.

Road crossing design and fabrication should minimize pressure drop and provide an internal cross-sectional area equal to or greater than that of the fully pressurized hose assembly at all points.

Certified hydrostatic pressure tests should be performed upon fabrication.

Road crossing design should incorporate

a) A drain plug in a low area to facilitate drainage.
b) Pig stoppers to prevent pigs from entering and becoming lodged in the crossing.
c) Appropriately rated handling devices such as lifting eyes, fork pockets, etc. These facilitate handling and can prevent damage that can lead to subsequent failures.

5.3.2 Half-moon Style

The following are guidelines that should be followed for half-moon style road crossings:

a) Used with lay flat hose size for which it was designed or smaller.
b) Road crossing dimension of the lay flat hose path should be large enough to ensure that a fully pressured lay flat hose does not contact the half moon.
c) Should not have sharp edges.
d) Protective matting can be used to mitigate abrasion issues.

5.3.3 Coffin Style

The following are guidelines that should be followed for coffin style road crossings:

e) Road crossing dimension of the lay flat hose path should be such that the perimeter of the “coffin” is larger than the circumference of the fully pressured conduit.
f) If the lay flat hose path is smaller than the circumference of the fully pressurized lay flat hose, the coffin should be engineered and fabricated to at least the same pressure rating of the conduit system with which it will be used.
g) Road crossings should be engineered and fabricated such that the inlet and outlet of the lay flat hose are tapered to minimize strain on the lay flat hose as it regains its circular shape, and to avoid sharp edges that could come into contact with conduit.
h) The lay flat hose path should be clean and free of debris before laying hose inside “coffin”.

5.4 Water Way Crossings

Lay flat hose shall not be submerged, fully or partially, in any live body of water.

As a minimum, the route plan shall include the following:

a) The crossing of dry creek beds and use of culverts shall be evaluated for risk of flash flooding and potential flooding impact to surrounding roadways.
b) The use of engineered solutions such as stream trusses to prevent submersion of the lay flat hose.

NOTE Some jurisdictions might have requirements related to crossing of waterways, including bridge crossings, ephemeral streams (dry beds), and flowing water.

5.5 Boring Designs

If a lay flat hose is to be installed through a boring, the operator shall ensure that the bore has been designed using good engineering practices and is suitable for operating conditions.

A bore with flange connections shall be designed to the appropriate maximum allowable working pressure (MAWP).

The bore should provide a means of protecting the lay flat hose around the edge of the entrance or exit. The pressured state of the lay flat hose (diameter expansion, snaking) should be considered at the inlet and outlet and appropriate staking should be used to prevent contact.

NOTE This document does not provide guidance on design or construction of borings, and on installation of lay flat hose through borings. The user is advised to consult experts during the planning process.

5.6 Hose Assembly System Design

5.6.1 General

The hose assembly system shall be designed to safely and efficiently transport water through lay flat hose.

NOTE Hose assembly system design is an iterative process using a hydraulic analysis to identify the optimal equipment configuration for safe water transport at the required rates along the selected route.

5.6.1.1 Hydraulic Analysis

A hydraulic analysis performed at the design temperature shall be completed to calculate the pressures that the hose assembly system will be exposed to in all potential operating conditions. High-risk locations shall be identified and shall include:

a) Pressure losses through all fittings, road crossings, and other inline equipment that can affect the pressure profile of the hose assembly system.
b) The topography of the route.

Warning — Low elevation points are subjected to increased hydrostatic pressure and have an increased risk of overpressure events that can cause injury or death.

5.6.1.1.1 Hydraulic Analysis Report

A hydraulic analysis report should be prepared and provided to the Owner outlining the results of the hydraulic analysis. The report shall contain:

a) MAWP of the hose assembly system
b) MAOP of the hose assembly system
c) Design flowrate and maximum allowable flowrate
d) Expected pressure along entire route in both flowing and hydrostatic conditions
e) Maximum expected pressure of the hose assembly system
f) Maximum pressure/high pressure shut down set points at each pump location

On request of the Owner, the hydraulic analysis service provider shall provide a job-specific cause and effect document that describes what happens when high pressure set points are exceeded, what alarms can occur, what shutdowns can occur, and what notifications can be made.

5.6.1.2 **Flow Conditions**

When performing the hydraulic analysis, the following flow conditions, at a minimum, shall be evaluated:

a) Initial fill
b) Pre-Service Test
c) Low flow
d) Normal Operation
e) Dead Head
f) Hydrostatic, no flow condition

5.6.1.3 **Calculations**

When performing calculations, the pressurized ID of the line shall be used.

NOTE The pressurized ID might be different than the nominal ID of the line.

5.6.1.4 Pressures

For a specified flow rate, the hydraulic analysis shall determine hose assembly system pressures at the locations of all pumps. Dead head pressure vs. flowing pressure at given points along the entire hose length should be determined. Points of high and low elevations should be identified, including devices that have the potential to cause pressure drop.

Caution — Pressure in the line of a damaged lay flat hose or lay flat hose assembly can result in water leakage and cause damage at critical areas such as environmentally sensitive areas.

5.6.1.4.1 Maximum Allowable Operating Pressure

The hydraulic analysis shall use the MAOP to define the following parameters:

a) test pressures,
b) normal operating pressure range based on the range of flow rates expected to be delivered during the job,
c) design pressure,
d) pump overpressure protection set points based on route topography.

The MAOP may be defined by the Owner and/or the Operator, and the hose assembly system MAOP shall be the lesser of the two. If no MAOP is defined, the MAWP shall govern the hose assembly system. If the hydraulic analysis shows that the desired configuration has a pressure that exceeds the MAOP, an alternative equipment configuration shall be evaluated. Based on the results of the analysis, suitable components shall be selected with MAWP that are greater than or equal to the MAOP and/or design pressure at all points along the route. The lowest rated component within the hose assembly will define the MAWP of the entire hose assembly.

The MAWP of all fittings installed in the hose assembly shall not exceed the MAWP of the lay flat hose. Job-specific startup and shutdown procedures shall maintain pressures below MAOP at all times per the requirements of 5.6.

Warning— Exceeding the MAWP of the lay flat hose can cause injury or death to personnel in the event of a failure.

5.6.1.5 Weather Effects

Winter weather operational requirements should be made during the hose assembly system design process, see Section 10.3. The temperature of the fluid shall not exceed the maximum allowable temperature as defined by the manufacturer of each component (hose, fittings, pumps, etc.)

5.6.2 Map of Route

A map with final lay flat hose route should be developed and should include the following:

a) Location of fluid source and destination
b) Location of pumps and any other in-line equipment along the route
c) Elevation profile of the route
d) Identification of any environmentally critical areas along or near the route

5.7 Water Hammer

The following guidelines should be followed to prevent water hammer:

a) Valves which are not intended to be operated during water transfer operation shall be secured in position with a latch, pin, or similar device.

b) Valves should be closed slowly.

c) Owner and operator shall consider additional engineering and administrative controls to reduce the risk of water hammer or surge.

Warning- Sudden spikes in pressure can cause water hammer resulting in loss of containment that can cause damage to the environment, bodily injury or death.

5.8 Overpressure and Abnormal Pressure Protection

Pumps in water transfer operations shall be outfitted with pressure monitoring devices on the discharge side so that overpressure and abnormal changes in pressure can be closely monitored. This discharge pressure gauge should be observable from a location that minimizes risk to personnel in the event of a discharge line failure. Hose assembly systems shall be monitored so that operating pressures along the hose assembly system during operation can be compared to the hydraulic analysis to verify that the analysis accurately models the route. If there is a large discrepancy, the analysis should be revisited to understand the reasons for the discrepancy.

NOTE This can be done with manual gauge monitoring, or more complex electronically monitored or automated systems.

5.9 Pressure Monitoring Devices

If pressure monitoring devices are to be used, they should be capable of transmitting an alarm prior to shut down in an event of overpressure or abnormal pressure trends. These technologies may include the use of a pressure transmitter, cellular or radio capabilities, and programmable logic control systems to communicate across a network of pumps. Other technologies may be acceptable with the Owner's consent.

NOTE There are several technologies currently in practice to perform overpressure and abnormal pressure protection.

5.9.1 Overpressure Protection

If automated overpressure protection is used, it shall activate when the pressure sensor detects MAOP at the lowest relative elevation point along the transfer route as determined by the hydraulic analysis provided by the Operator, or at a pressure predetermined by the Owner, whichever is less. If alarms are used for overpressure, they should be set at least 10% below the high pressure shutdown setpoint.

5.9.2 Automated Abnormal Pressure Protection

If automated abnormal pressure protection is used, it should be capable of triggering a shutdown upon detection of abnormal or sudden high or low pressure changes, as either can indicate loss of primary containment. The protection system should also transmit an alarm to the operator in the event of a gradual increase or decrease to abnormal conditions.

5.9.3 Alarm Systems

If alarm systems are used, they should be capable of providing a visual or audible alarm observable by the operator at the location and/or providing remote alarms to off-site personnel. Alarm systems can also be capable of providing alarms to each pump location in the system.

5.9.4 Automatic Shutdown Devices

If automatic shutdown devices are used, at a minimum those devices shall be capable of disabling or limiting each pump at defined pressure set points.

NOTE Some technologies might be capable of disabling or limiting all pumps within a hose assembly system.

After the activation of an automatic shutdown device, the operator should not restart the equipment until the hose assembly system has been inspected to ensure its integrity, and appropriate corrective action has been taken.

5.9.5 Calibration

Pressure monitoring devices shall be calibrated per manufacturers recommendations. Devices shall be tested for proper function after every deployment and prior to start up.

5.10 Signage and labeling

Temporary water transfer lines shall be labelled with signage indicating the Operator of the line and relevant contact information for the Operator.

Prior to deployment, jurisdictional requirements should be reviewed regarding additional signage for temporary water lines.

Signage should be placed where the line enters or exits a public right-of-way, and at appropriate locations along the lay flat hose pathway so that the public can identify the operator should an issue arise. Operators should consider signage where a line crosses from one stakeholder's property onto another.

5.11 Community Relations

NOTE API Bulletin 100-3 covers many different aspects of community relations pertaining to oil and gas operations. See Reference [1] in Bibliography. Specifically, the document breaks oil and gas activity into five phases: entry, exploration, development, operation, and exit. For most temporary water transfer operations, most community interaction will be during the entry, exploration, and development phases.

In addition to the information in Bulletin 100-3, there are additional considerations with respect to stakeholder interaction for water transfer that should be addressed including, as a minimum, the following:

a) Effective communication of the expected timeline, route, and job duration before lines are installed.
b) Ensure landowners and other stakeholders have up to date contact information for the Operator and/or Owner so problems can be identified and rectified promptly.
c) Consider and discuss seasonal variations (agricultural, academic, etc.) in landowner needs with respect to access, routing, and mobilization/demobilization of lines.
d) Consider dissemination of education materials about the quality and quantity of water that will be in the lines, and about the reduction in water truck traffic that the use of the lines provides the community.
e) Consider educational materials about public safety as it relates to temporary water lines, and how people should behave around water lines that are under pressure.
f) Continuously improve and maintain high standards and behaviors for safe operation of water lines, minimizing landowner disruptions, and returning rights of way to similar or better condition than they were found.

6 Deployment and Handling of Lay flat Hose

6.1 General

a) Hose should be kept clean and free of debris.

b) Hose shall never be used as a tension device. (i.e. pulling, rigging, etc.)

c) Jacket damage should always be addressed and the hose either repaired or discarded. All repairs shall be performed in accordance with manufacturers recommended field repair procedures.

d) Couplings should always be inspected for proper assembly (torque, hardware rating, etc.), and jacket slip before transporting water.

e) Manufacturer's instructions shall be referenced when servicing couplings or components of the hose assembly system.

f) Vehicles shall not be driven over the hose.

g) Damaged and out of service hose should be clearly identify and quarantined to prevent inadvertently rigging up damaged hose.

NOTE Consider the weight of at least 20-30 ft. (6 – 9 m) of hose when manually lifting or moving limp hose

6.2 Hose storage

The lay flat hose should be stored on a spool. If the hose cannot be stored on a spool the following guidelines should be followed:

a) Lay layered on clean and even ground for visual inspection.

NOTE Piling multiple, individual lengths of hose on top of each other results in tangling.

b) Lay flat hose shall not be stored on sharp objects.

6.3 Spools

6.3.1 Inspection

Operators should inspect spools per the SOP of the Operator, including a visual inspection prior to spooling of hose, and maintain them in proper working order. At a minimum, maintenance procedures should include the following to prevent damage or accidents.

a) Bearings should be greased (if applicable).
b) Driven shafts should be free of burrs and damage.
c) Spool flanges should not be warped to the extent that prevents spooling/unspooling hose freely.
d) Spool core and spool shall be free of sharp edges and be sufficiently wide to permit inserting/extracting the first coupling without damage.

e) Any hydraulic actuators, hoses, connections should be maintained in proper working order at all times to ensure proper deployment and retrieval.

6.3.2 Loading Lay Flat Hose on a Spool

a) The length of hose on a single spool should always be limited to the manufacturer's recommendation.
b) Spools should be loaded in a manner that prevents any part of the hose or hose assembly from extending beyond the edges of the flanges or the spool envelope.
c) Spooling multiple, connected, short hoses on a single reel should be avoided. This practice can damage the hose and/or couplings and/or create an unbalanced load that could rotate unexpectedly.
d) If hose is to be spooled overlapping couplings, it should be done such that the hose will not be damaged or tangled.
e) On multi hose spools, the hose should be spooled from one side of the core to the other side of the core, reversing after each layer in order to maintain a flat surface across the width of the core.
f) Free rotation of loaded spools should be avoided in order to prevent unwanted spool movement, which can lead to equipment damage.
g) Avoid tangling, sometimes called bird nesting, of hoses on reels.

6.3.4 Spool Handling and Transport

a) Spools should be handled and lifted using adequately rated machinery (skid steers, forklifts, tractors, etc.)
b) Spools should be handled in a manner to avoid striking other spools or objects.
c) When set on flatbed trailers, spools should be secured using adequate, appropriately rated, rigging equipment per local jurisdictional requirements.
    i. Total weight should be kept under prescribed weight limit for trailer and total rig.
    ii. Spools should have appropriate clearance.
d) Spools shall be properly secured to prevent rotation of spools when transporting.

6.4 Tracking and Traceability

6.4.1 Marking

For purposes of traceability, lay flat hose should be marked by the manufacturer with identifying information that includes, at a minimum:

a) Manufacturer's name
b) Manufacturing location code (e.g. factory location, manufacturing line number)
c) Lot number, if applicable
d) Product class, type, or number
e) Date of manufacture
f) Maximum continuous pressure

6.4.2 Tracking

The service company should track the use of each lay flat hose using a record keeping system that documents, at a minimum:

a) The product traceability information in 6.4.1
b) The customer and service location of the hose for each deployment
c) Number of deployment days
d) Approximate cumulative pressure cycle count
e) Approximate cumulative amount of water flowed through the hose
f) Approximate historical account of the quality of water flowed through the hose
g) The results of visual inspection of the hose

The service company records should be retained for the service life of the hose.

7 General Lay Flat Hose Deployment

7.1 Guidelines

The following guidelines should be used for the general deployment of lay flat hose:

a) The installed hose assembly should maintain a minimum of 10 ft. (3 m) clearance from roadways, including lease roads or other potential restrictions.

NOTE It is common for rights of way and other agreements between the Owner and stakeholders to be required prior to deployment of a hose assembly system by the Operator. Work permits or other specialized permissions may also be required depending on local regulations.

b) Lay flat hose should be laid out to eliminate sharp bends.

All bends should be equal to or larger than the manufacturers recommended minimum bend radius. This includes bends formed when attaching to equipment, pumps, and hard piping. Mitigations to eliminate sharp bends should be utilized where possible as per Section 4.10 Pump Connections and Other Fittings.

c) Lay flat hose shall not be rigged for pulling by using rope, chain or any other rigging device in a choking hitch around the jacket.

Caution - A choking hitch can bind the lay flat hose tightly promoting delamination and/or reinforcement damage to the lay flat hose.

d) The speed of the deployment vehicle shall be adapted so the lay flat hose is not stretched, placed in tension, or dragged across the ground.

Warning - Excessive speed of deployment can induce unexpected lateral movement of the hose on the ground which can cause bodily injury or death, and/or property damage.

e) Deployment should be performed in a controlled manner to prevent unnecessary slack in the hose lay.

Warning - Lay flat hose slack can promote snaking under pressure and cause bodily injury or death.

f) Avoid deploying hose on rocky, hard, sharp, and other potentially damaging objects. Normal hose movement under pressure/flow and vibrations can cause abrasion damage to the hose assembly when in contact with such objects.

g) Upon deploying an additional section of hose, it should be connected to the previously deployed hose on the ground to prevent large gaps between couplings.

NOTE These gaps can be difficult to pull together for coupling once the hoses are fully laid out.

h) If a coupling must be freely rolled over the top of the spool, a means to prevent the free coupling from falling should always be used (rope, strap, etc.).

Warning A coupling rolling freely on a spooled hose can roll over the top of the spool and fall to the ground on the other side and cause equipment damage and/or bodily injury or death. Personnel shall not be positioned under a coupling that is freely rolled over the top of the spool.

7.1.1 Pulling a Lay Flat Hose

If lay flat hose is to be pulled, a "ski rope" device should be used, see Figure 1. The ski rope device should be made of a bar that is at least as long as the flat width of the hose. The hose should be folded over the "ski rope" bar no less than 3 feet from the coupling.

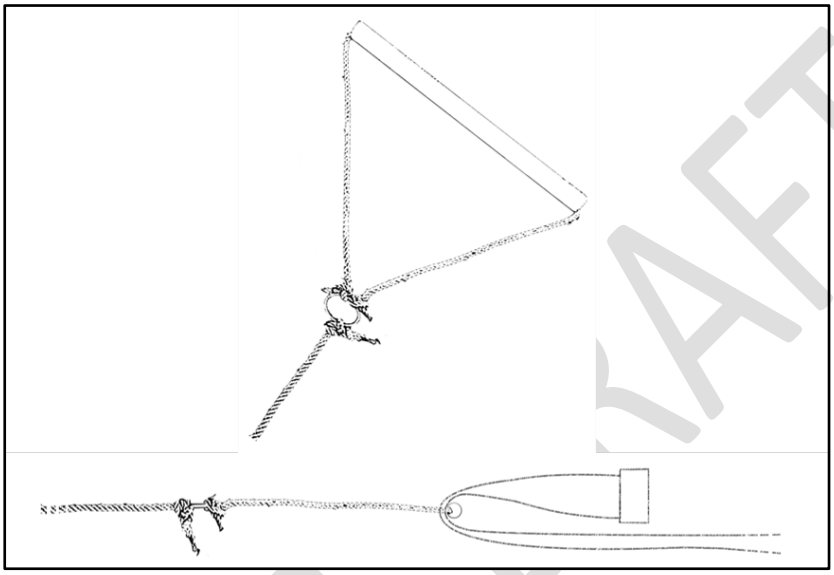

Figure 1: Top - Ski rope showing rigid bar over which the hose is looped for pulling. Bottom - Lay flat hose (right) looped over ski rope bar for pulling.

7.2 Lay Flat Hose Under Pressure

For lay flat hose under pressure, the surrounding area shall be inspected where movement is expected:

a) If sharp objects cannot be removed or avoided, a suitable barrier (protective matts, old hose jackets belting, geotextiles, etc.) to protect the hose from abrasion damage should be used.

b) In areas where hose movement (roads, hills, etc.) is not acceptable and/or cannot be avoided, stakes or fence posts should be used as restraints to limit the hose movement.

The restraints put in place shall be robust enough to resist being displaced or broken.

c) Stakes and posts should have non-abrasive sleeves securely installed (plastic pipe, rubber hose, etc.) over them to prevent abrasion damage to the hose.

7.3 Moving the hose during a job

Situations can arise after the line is deployed where it is necessary to move pumps or modify the route. If this occurs, the hydraulic analysis shall be revalidated.

If the lay flat hose needs to be moved during a water transfer, the following guidelines should be used:

a) Water should not be flowing through the lay flat hose.
b) The lay flat hose should not be pressurized.
c) The weight of the water in the hose should be considered when selecting a method for moving the hose (i.e. by hand vs. using machinery).
d) Sharp or abrasive terrain should be identified prior to moving a filled or partially filled line.

Caution - The extra weight in a lay flat hose filled with water can contribute to more severe external lay flat hose damage.

e) Sharp implements or tools such as forklift forks, prybars, etc. should not be used to pick up and/or move the hose.

Caution - Lifting the lay flat hose with forks or other lifting devices while the hose is filled, or partially filled, with water can cause damage to the hose.

7.4 Completion of Deployment

Upon completing deployment of lay flat hose, the route map developed in Section 10.5 shall be updated to reflect the as-built position of the lay flat hose. The route map update shall include the following:

a) showing entire pump route,
b) pump placement,
c) isolation valves,
d) road crossings,
e) culverts/road bores,
f) high environmental impact points (creek/stream crossings), and
g) location of spill response equipment.

8 General Guidelines

a) Road crossings shall be installed anywhere the hose assembly traverses a roadway.

b) Barricades should be installed anywhere there is significant potential for a vehicle to drive over or impact the hose assembly along its route.

c) Road crossings used near the intersection of two or more roads should be placed sufficiently far from the intersection that traffic can safely turn onto the intersecting road before going over the road crossing.

d) At a minimum, road crossings should be as wide as the roadway being crossed.

e) If the crossing cannot be made wide enough, then the safe crossing zone shall be clearly marked, and barricades should be used to prevent crossing outside of the safe crossing zone.

f) Road crossings should be set on flat, level ground free of large rocks or debris.

g) Road crossings should be staked or otherwise secured to prevent movement caused by lay flat hose movement or other factors. If the crossing is over a paved road, staking might not be feasible, but other means to secure the road crossing from movement should be implemented.

h) Road crossing ramp angles should be such that passenger cars can cross without the vehicle's chassis contacting the crossing. Dirt can be used to adjust ramp angle.

i) Dirt cover and appropriate ramp angles should be maintained during the duration of the transfer and until removal of road crossing.

j) Road crossings should not restrict the flow of water in the hose. If it does restrict the flow, the hydraulic analysis shall be updated to reflect the impact.

k) Any lay-flat hose assembly entering or exiting road crossings, culverts, or bores should be protected from damage caused by contact with the edge of the entrance or exit. The pressured state of the hose (diameter expansion, snaking) should be considered at the inlet and outlet and appropriate staking should be used to prevent contact. Road crossings shall be large enough to hold the lay flat hose and fittings; and shall freely accept the entire hose width without pinching or rubbing to prevent damage to the hose assembly.

l) Road crossings shall not utilize existing culverts or cattle guards unless used to reduce impact on local roadways.

m) The impact of the presence of the lay flat hose on the storm water drainage system in the area should be considered.

n) A visual inspection and evaluation of the hose assembly should be performed after a storm event.

o) Signs with emergency contact information should be installed at road crossings to expedite response in the event of an incident.

8.1 Signalization

Appropriate signalization should be used to alert drivers of vehicles to the presence of the road crossing. Multiple means can be used such as traffic cones, reflective stickers, reflective signage, etc.

Signalization guidelines should be followed:

a) Positioned such that the passable width of the road crossing is clearly highlighted with reasonable margin to make vehicles aware of the safe place to cross the road crossing.

b) Of sufficient height so that drivers of vehicles (passenger cars, trucks, etc.) can easily see them.

c) Of sufficient size that drivers of vehicles can see them from a reasonable distance, as deemed by the service and speed of the roadway.

d) Maintained for the duration of the transfer and until removal of road crossing.

NOTE The Manual on Uniform Traffic Control Devices, United States Department of Transportation, offers comprehensive guidance. See Reference [5] in the Bibliography.

8.2 Retrieval and Respooling

8.2.1 Retrieval Operation

Prior to retrieval, the hose assembly system should be flushed with fresh water using a minimum of three times the line volume, drained, and pigged. The hose should be empty of fluid and depressurized for respooling operations.

NOTE This ensures that the next transfer will not receive residue from the previous use.

8.2.1.1 Draining and Pigging

The operator shall ensure that all equipment is properly sized, rated, functional, and secured; and that all personnel are trained and certified for the operations.

a) The air compressor shall have adequate means to provide and regulate the air pressure.

b) All pneumatic connections shall be adequately rated for the service and safety pins shall be used if a quick connect attachments are used.

c) Whip checks shall be used on all pneumatic lines.
d) The line to be pigged should not be open-ended or unrestrained. It
e) The line to be pigged shall be securely anchored or restrained to prevent any uncontrolled movement of the hose assembly.

NOTE Pigging is performed to mitigate environmental risks associated with uncontrolled spills.

8.2.1.1.1 Draining and Pigging Standard Operating Procedure

The operator shall have a company-specific standard operating procedure (SOP) for draining and pigging operations. The SOP shall provide step-by-step guidance regarding safety, planning, equipment selection and setup, and procedures for draining and pigging the line, including disposition of fluids resulting from the operation. As a minimum, the following should be included within the SOP:

a) The line should be drained by gravity towards either the source or the transfer destination in compliance with local regulations for the fluid type.
b) Pigging should be planned for during the initial job design and wyes placed to allow for a pig to be inserted without having to break the line.

   Caution - A break in the line can subjecting the area to an unplanned release or spill and cause damage to the environment.

c) During pigging operations, establish adequate means of communication to inform all parties in the immediate area that the hose assembly is being pressurized, as well as those who might approach when pigging operations are underway.

   NOTE - This communication may include but is not limited to flaggers, signage, and barriers.

d) Pressure required to move the pig should be calculated.
e) The air pressure in the hose assembly system shall not exceed 120 percent of the pressure required to perform the pigging operation.
f) All connections shall be secure.
g) All valves in the air hose assembly and lay flat hose assembly should be closed during the rig up to prevent water from traveling unexpectedly, and only opened in a controlled manner by qualified operators during the pigging operation.
h) Before any air is applied to the hose assembly, a qualified inspector should walk the path of the line to identify areas where the pig will not pass. Areas of the lay flat hose that might cause the pig to become stuck should be evaluated and an alternate method to remove water from the hose assembly should be used in those areas.
i) The air compressor shall be monitored by a qualified operator at all times while the pigging operation is underway, to quickly shut off the air compressor and start venting air from the line if needed.

j) Air pressure should be added in a slow and controlled manner to begin pigging operations.
k) A qualified person should walk the line during the pigging operation to monitor the pig's progress along the hose assembly's length. The line walker should have a reliable means of communication with those operating the pumps to immediately report any findings from the line walk.
l) The air compressor should be operated in a manner to maintain a safe pig speed along the length of the hose and to land the pig at the catch point at a safe velocity.

NOTE 1 - Depending on the length of the line, the pig speed will increase as the air pressure builds behind the pig and the water column in the lay flat hose.

NOTE 2 - A safe speed is one that results in a pig kinetic energy that is within the design limits of the pig catching equipment being used on the hose assembly system.

m) The air compressor shall not be disconnected from the hose assembly system until complete depressurization of the line has been achieved.

Warning — All personnel shall remain safely clear of the pig catch point while pigging is underway to avoid bodily injury or death.

8.2.2 Respooling Operation

The re-spooling operation should not be used to drain the hose. The following guidelines should be followed for respooling lay flat hose:

a) Spools should be the size of the lay flat hose or larger.
b) The first coupling should be secured in the spool core before attempting to rotate the spool.

Warning — Personnel shall stand clear of hose, couplings, spools and retrieval implements. Hazardous movement can occur and cause bodily injury or death.

c) The hose should be re-spooled in a neat coil with minimal slack, and without twists.
d) Movement of the retrieval vehicle should be done in a way that maintains consistent tension on the hose being retrieved.
e) A tensioning device such as rollers or brakes should be used to maintain consistent tension on the hose while re-spooling.

CAUTION — Excessive tension can overpower the re-winding drive causing equipment damage and/or personnel injury.

f) The retrieval vehicle operator should maintain visual contact with operations utilizing additional ground spotters as needed.

g) Operators shall put only one segment of hose on each spool. There should only be one set of couplings on the spool, one at each end of the hose.

h) The end coupling should be disconnected and not dragged to the spool.

i) After the hose is spooled, the spool should be locked to prevent free rotation, and the coupling should be secured in place so that it does not hit the spool or hose.

j) Any damage to the hose observed during retrieval should be marked and tagged.

8.3 Pump Connections & Other Fittings

The following list of guidelines should be followed:

a) All fittings installed in line with the hose assembly system shall have MAWP equal to or greater than the hose assembly system.

b) Connections to pumps should be made in a way to limit external loads on fittings and avoiding kinking of the hose and may include but are not limited to the following:

1) Adequately rated, reinforced, suction style hose may be used to lower the connection to the lay flat hose assembly to ground level where the connection is fully supported.
2) Adequately rated, rigid fittings and piping may be used to lower the connection to the lay flat hose assembly to ground level where it the connection is fully supported.
3) Pointing the pump outlets and inlets down 45 degrees may be used to minimize external loads on couplings and reduce bending on hose.
4) Whip checks may also be used at connections to pumps to prevent unrestrained movement of lay flat hose in case of unexpected disconnection from pump

c) If additional fittings are added to the pump suction or discharge, additional support or cribbing should be used to alleviate excessive strain on the connection and reduce bending stresses on the hose.

d) Flanged connections should be assembled and torqued per industry standards, manufacturer's instructions, or SOPs, and marked with the date and the initials of the installer.

e) Rigid fittings should be set on stable ground and secured against movement caused by elongating or twisting hose.

f) Rigid fittings should not be set at a height where connections will be subjected to excessive external loads and where air could be trapped.

g) Field serviceable hose couplings should be assembled per the manufacturer's instructions, including torque specifications, and inspected prior to use. Special attention should be paid to the following during assembly:

1) Verify general coupling condition, including fasteners and gaskets as applicable.
2) Verify collar segment torque if applicable.
3) Verify hose seating to identify hose slippage.
4) Verify coupling bolt torque and/or gap if applicable.
5) Verify connection indicator alignment if applicable.

h) Mating of coupling to hose should be marked with date of installation and initials of installer.

9 Water Transfer Operations

a) All water transfer pumps shall have a working pressure gauge that is clearly visible by an operator at the control panel of the pump. The range of the gauge shall be such that the MAOP and MAWP fall within the 20% to 80% range of the gauge. (e.g. 1000 psi gauge implies MAOP and MAWP are both between 200 psi and 800 psi.)

b) Once the water transfer has started and the hose is under pressure, the entire line shall be inspected again to make sure that there are no sharp bends, twists, or kinks in the hose.

c) Since hoses can shift or move while being pressurized, pressure should be increased slowly, until proper working pressure is attained. After pressurization, the hose assembly should be inspected for damage. Confirm that the final hose location is acceptable for operations.

d) Hoses placed along grades should be supported using straps and/or stakes to avoid sliding down the slope when pressurized.

e) Any damages to the hose or couplings should be clearly marked so that repairs can made to the damaged area.

f) Hoses or couplings judged to have damage that is a threat to hose assembly system integrity or safety shall be removed from service immediately.

g) Flow rates and pressures at the inlet and outlet of pumps should be continuously monitored while in operations.

10 Pre-Job Testing

10.1 General

A qualified person shall oversee the execution of pre-job testing.

NOTE Pre-job testing is performed to mitigate environmental and operational risks associated with uncontrolled spills.

10.1.1 Pre-job Testing Record

A pre-job test sign-off document shall be prepared for a lay flat hose operation and should include:

a) Start time
b) End time
c) MAOP of line
d) Location at which the pressure is being monitored
e) Pressure at location being monitored
f) Start pressure of test
g) Ending pressure of test
h) List of all untested connections in the hose assembly system

The qualified person overseeing the execution shall sign off on the pre-job test document to certify that the test was conducted successfully.

Any connections that cannot be tested as part of pre-job testing shall be visually inspected prior to being placed in service and documented as part of the pre-job test sign off document.

10.1.2 Hydrostatic Leak Test

For all transfer operations, a hydrostatic leak test shall be performed such that the point of the lowest relative elevation along the transfer route is tested to the MAOP.

When performing hydrostatic leak test, pressure in line shall be tested at MAOP for a duration of 30 minutes, or the time it takes to drive the route to visually inspect the line for the presence of a leak, whichever is greater. Confirm that the pressure throughout the duration of the test does not drop more than 10%.

Any observed leaks shall be noted and repaired in accordance with manufacturers field repair specifications, and the line shall have a hydrostatic leak test performed again before proceeding.

10.1.2.1 Hydrostatic Leak Test Using Water

A hydrostatic leak test using fresh water is preferred if unfeasible or impractical, brackish or produced water may be used.

a) If brackish or produced water is to be used, a low-pressure air test should be performed to identify gross leakage prior to hydrostatically testing the hose.
b) Water transfer operators shall have a specific procedure in place for low-pressure air testing that is applicable to their scope of work.

Warning - All pressure-containing systems and pressure tests present stored energy hazards, and pneumatic stored energy hazards can cause bodily injury or death and require unique cautions as compared to hydraulic stored energy hazards.

NOTE 2 Operators developing their own testing procedures and limits can refer to ASTM F1417-11a – Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air (2015) for additional guidance on low-air pressure testing. Section 6.1.4 recommends not exceeding a pressure of 9.0 psig when air testing, and Section 8 recommends specific procedures for air testing using either a constant pressure method or a time-pressure drop method. See Reference [6] in the Bibliography.

10.1.2.2 Hydrostatic Leak Test Using Air

If an air test was conducted, operators might need to introduce water into the line in a manner to prevent trapping air at intermediate high points. A field operational practices should be followed:

a) Fill the line while using a soft foam pig or with a slow water fill.
b) If a pig is used, catch the pig properly at the end of line to be tested
c) Monitor water flow as necessary to ensure sufficient air removal from the line.
d) Visually inspect the line for trapped air and vent where appropriate.

NOTE Various methods exist to remove trapped air from a hose assembly system. These include but are not limited to high point vents, pigging the line, and pumping fluid at high rates through the line. Methods can be job specific.

Consider hose expansion and snaking while initiating a pressure test.

1) Ensure after the initial test that any movement of the hose during the test has not resulted in a kink that excessively restricts flow or violates the manufacturer's recommended bend radius.
2) Ensure the movement has not shifted the hose into a potential hazard or out of the specified ROW.

10.2 Extended Shutdowns

If a line is left in a non-operated and unmanned/unmonitored condition, this is considered an extended shutdown and create the potential for undetected damage to the line or leaks which might occur prior to, or during, restart. The procedures of this section shall be followed in the event of an extended shutdown.

10.2.1 Water should be drained from the affected line using the draining and pigging methods in Section 8.2. If the hose assembly system was used in a saline/PW service, the line should be pigged to evacuate and then flushed with fresh or brackish water with total dissolved solids (TDS) less than or equal to 5000 mg/L, then evacuated.

10.2.2 Adequate water storage capacity should be available prior to line evacuation so that the line can be evacuated of water without overfilling the storage vessel or pond.

10.2.3 The entire line should be visually inspected for damage and wear prior to placing the hose assembly system back in service. Any components failing to meet the requirements of the job should be replaced or repaired prior to restarting.

10.2.4 After an extended shutdown, a pre-job test shall be repeated in accordance with Section 10.1 prior to resuming operations.

10.3 Environmental & Weather Limitations

a) Weather forecasts and current conditions should be monitored by the operator. During extreme environmental conditions (e.g. tornados, floods, fires, etc.) actions should be taken to evacuate line contents to reduce potential for spills as long as it is safe to do so before leaving the job site.

b) If weather conditions are anticipated to create flooding conditions, lay flat hose in non-fresh service should be flushed.

c) After a flooding event the hose shall be inspected for damage.

d) Water transfer operations in freezing temperatures require modified procedures. Operators should develop and maintain cold weather plans that address the special procedures needed for cold weather operations.

Caution - Frozen lines, pressure spikes, and expansion due to ice, can result in an unplanned release and damage to the environment.

10.3.1 Freezing Temperature Operations

The following guidelines should be followed in below freezing temperatures:

a) The line should be filled slowly to reduce the chance of building slush or ice plugs in the line.

b) If slush or an ice plug begins to form, the line should be opened to allow the ice to clear. If utilizing brackish or PW, ice and water should be contained.

c) Should keep the fluid moving in the line.

d) Pigging of the line might be necessary if an extended shutdown is anticipated that could potentially cause the line to freeze.

10.3.2 Line Freeze Mitigation

a) Heaters, typically installed in-line between the source and delivery location, may be used to prevent freezing.

b) When in-line and external heating is used, the hose and equipment manufacturers' maximum temperature limit shall not be exceeded.

c) Line recirculation may be used to mitigate freezing.

d) If the mitigation techniques described in this section are not sufficiently effective, the operator should pig and evacuate the line.

10.4 Operational Monitoring

10.4.1 Leak Detection and Response

a) The operator shall provide adequate manpower and/or remote monitoring equipment to safely conduct pump operations and monitor lines to mitigate the risk of leaks.

Environmentally sensitive areas such as creek or stream crossings might require additional supervision.

b) When transferring non-fresh water, regular visual monitoring shall be performed along the entire length of the hose assembly while in use.

c) The operator shall develop and maintain a spill response plan per 10.6. If a leak is detected the operator shall take the necessary steps to contain the spill. Plans should contain clear instructions for communication, mitigation, and remediation of the spill in accordance with 10.6

10.4.2 Field Communications and Surveillance

Effective communications shall be in place and confirmed before pumping operations begin, from the beginning to the end of the pump route.

Radios, cell phones, and other mobile communications devices should be used to ensure efficient communication.

10.5 Operational Documentation

The operator shall provide the following documents prior to a job. The documents shall be maintained on the work site for the duration of operations.

a) Hydraulic Analysis, see 5.6.1

b) Route Map – Route map should include maps showing entire pump route, pump placement, isolation valves, road crossings, culverts/road bores, high impact points (creek/stream crossings) and spill response equipment as prepared in 5.6.2.

c) Communications Plan – Ensure proper contact list is prepared and available with correct contact information. Develop contact list with all appropriate personnel and local emergency contacts.

d) Cause and Effect Narrative – If applicable (refer to 5.6.1.1.1)

10.6 Spill Response

10.6.1 Spill Response Plan

An Operational Spill Response Plan should be prepared for all water transfer operations. The Spill Response Plan shall describe spill response actions that shall be enacted during any spill or unplanned release occurring during operation.

The spill response plan shall include the salinity and classification of the fluids being transferred, the topography, and environmental sensitivity of the route.

An Operational Spill Response Plan shall include:

a) Spill Response Contact List
b) Map of the line route – refer to 5.6.2
c) Assigned manpower roles and responsibilities
d) Worst case spill conditions with installed safeguards
e) Mitigation methods
f) Reporting requirements
g) Spill response kit

NOTE Some jurisdictions might require a spill response plan or surface use agreements.

10.6.2 Spill Response Kit

A spill response kit shall be prepared and kept near the operation for rapid response prior to beginning the water transfer operation. The kit can include a hose pincher, spare hose couplings, tool kits, plug kit, and temporary spill containment devices. Remediation in-situ should be considered where appropriate.

NOTE In certain jurisdictions remediation might be required.

NOTE The following references can provide guidance: Texas A&M Agricultural Extension Service document “Irrigation Water Quality Standards and Salinity Management Strategies.” See Reference [2] in the Bibliography, and *Remediation of Brine Spills: Lessons Learned,* Kerry Sublette-University of Tulsa. See Reference [3] in the Bibliography

Bibliography

[1] ANSI/API Bulletin 100-3 First Edition, July 2014, *Community Engagement Guidelines*

[2] Texas A&M Agricultural Extension Service document "Irrigation Water Quality Standards and Salinity Management Strategies."

[3] Remediation of Brine Spills: Lessons Learned, Kerry Sublette-University of Tulsa

[4] 40 CFR § 435.33 - *Pretreatment standards for existing sources (PSES)*

[5] *Manual on Uniform Traffic Control Devices*, United States Department of Transportation, https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm (accessed May 2019)

[6] ASTM F1417-11a – Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air (2015), ASTM International, West Conshohocken, PA.