PREVENTIVE MAINTENANCE FOR INDUSTRIAL & HYDRAULIC HOSE SYSTEMS

CHAPTER 3

Hydraulic Preventive Maintenance: Hose System Assembly & Installation

A solid preventive maintenance (PM) program is critical to the safe and productive operation of hydraulic and industrial hose systems. This multi-chapter Gates Fluid Power eBook delves into the many advantages gained by taking proper safety precautions and identifying system weaknesses before failure occurs. It also takes a step-by-step approach to hose and coupling selection, assembly, installation and troubleshooting.

Chapter 2 covered the criteria for selecting the right hose and couplings for safe, efficient hydraulic assemblies. With that groundwork laid, this chapter details the processes of proper hose assembly and installation.

HOSE ASSEMBLY

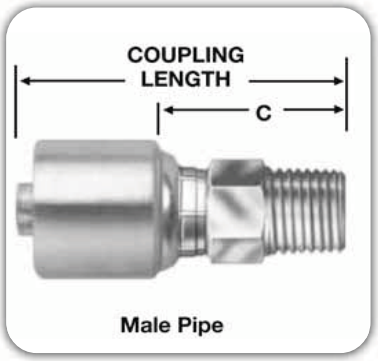
Components and equipment for the three types of hose assembly – permanent crimped, permanent swage and field attachable – may vary, but approaches to measuring, cutting procedures and fitting orientation are the same across the board.

Measuring Hose

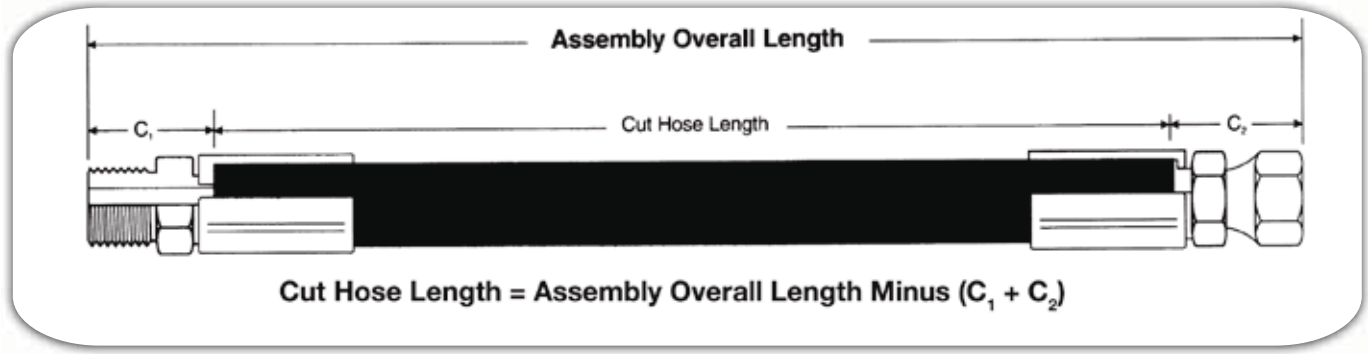
With some assemblies, the length must be within a tight tolerance for proper installation. This is especially true for short, high-pressure hose assemblies. Before cutting the hose, it is important to understand the difference between "cut hose length" and "assembly overall length" as shown below.

Cut-off value "C" is the length of that part of the coupling not directly in contact with or applied to the hose. Subtracting the sum of the two "C" values from the total length of the assembly determines the approximate hose length to be cut.

For male thread couplings, the cutoff is measured from the locking collar to the end of the threads as shown.

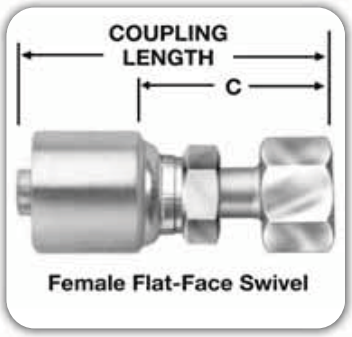


Male Pipe

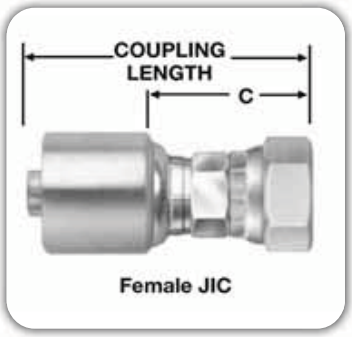


Cut Hose Length = Assembly Overall Length Minus (C_1 + C_2)

For straight female couplings, the cut-off is measured from the locking collar to the end of the nut or the seat depending on whether the nut can be pulled back exposing the seating surface as shown.

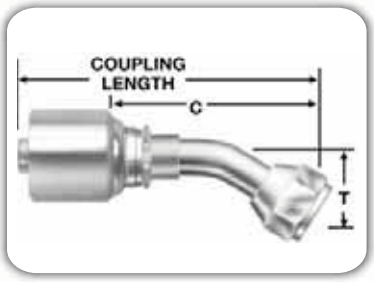


Female Flat-Face Swivel



Female JIC

Bent tube couplings are measured to the center line of the seating surface as depicted below.



SAE Length Tolerances for Hydraulic Hose Assemblies and Specified Hose Lengths

LENGTH	TOLERANCE
For lengths from 0" up to and including 12"	±1/8"
For lengths from 12" up to and including 18"	±3/16"
For lengths from 18" up to and including 36"	±1/4"v
For lengths above 36"	±1% of length measured to the nearest 1/8"

Cutting Hose

After the hose cut length has been determined, hose is cut with a cut-off saw. The blade may be either notched (serrated) or abrasive. A notched blade gives a clean, efficient cut on one- and two-wire braid hose and textile hose. Though notched blades will cut spiral hose, they are not recommended as they can dull quickly or become damaged.

The abrasive wheel efficiently cuts all hose types, including spiral-reinforced hose. The drawback with this blade is the amount of debris it creates from cutting. As the blade wears out, its diameter becomes smaller and eventually requires replacement.

Once the appropriate blade has been installed, the hose is placed in the bending fixture. This draws the hose away as it is cut, minimizing binding and making cutting easier. Hand-held cutters can be used on some textile-reinforced hose.

QUICK TIP:

When cutting hose, always wear safety glasses and avoid loose fitting clothing. Hearing protection is also strongly recommended.

Cutting Teflon® hose requires special consideration. It can be cut cleanly with a cutting shear. An abrasive wheel can also be used, but the hose's cutting location must be wrapped with heavy-duty masking tape at least twice. Once the cut is made, the Teflon tube must be deburred using a sharp knife. And, of course, tape must be removed before assembly.

QUICK TIP:

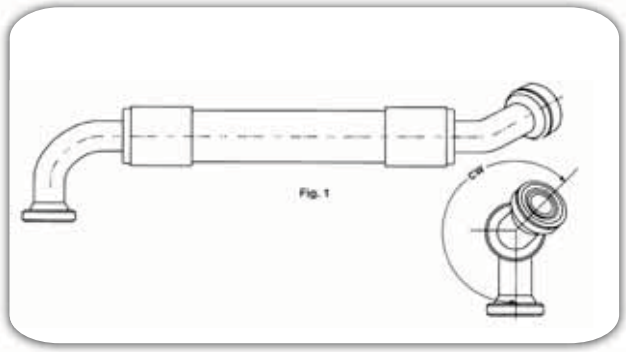
Cutting of any hose will generate some debris that can damage the hydraulic system if not properly removed. Always follow strict standards of cleanliness.

When cutting any hose, keep the cut as straight as possible and square with the side of the hose. The maximum allowable angle of the cut is 5°.

Fitting Orientation

Fitting orientation is necessary when both fittings are at an angle. They must be oriented to each other to ensure proper installation with minimal stress on the hose from twisting. First, the far coupling is positioned vertically

downward. Then the orientation angle is measured clockwise. The orientation angle tolerance should be ±2°.



Hose Preparation

Skiving

A wire abrasion wheel or hand-skiving tool may be used to remove the hose cover down to the reinforcement for coupling assembly and/or ferrule crimping. Thick-covered hose typically requires skiving because the ferrule serrations cannot bite through the cover and into the wire. Hoses with a thin cover, on the other hand, usually do not require skiving.

QUICK TIP:

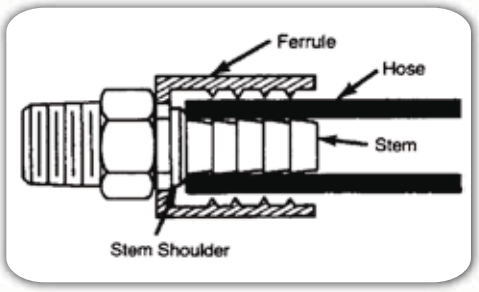
The skive length is the length of cover removed, and the skive diameter is the diameter after skiving.

Buffing

Some non-wire-reinforced hose requires buffing, which is similar to skiving but doesn't require removing the hose cover to the reinforcement. When a hose is buffed, its cover is removed but only to a specific diameter as defined by crimp data. A grinding wheel, and not a wire wheel, is used.

Preassembly Using Two-Piece Fittings

1. Lubricate the first two or three serrations on the stem with lightweight oil.
2. Clamp the stem in a vise on the hex portion, and push the hose onto the stem. The hose shoulder should be flush against the stem shoulder.
3. To check for full insertion, pull the ferrule down. The stem shoulder should be level with the top of the ferrule.



4. Push the ferrule so that it rests against the stem's hex. Hose and coupling are now ready for crimping.

Preassembly Using One-Piece Fittings

1. Place the hose next to the coupling. Use your thumb or mark the depth of the insertion.
2. With your thumb (or mark) in place, push the coupling until the shell touches the tip of your thumb or the mark. Twist it tightly to ensure it is fully inserted.

MegaCrimp® Coupling Insertion Tool

Confirming the proper insertion depth for Gates wire-braid hydraulic hose is simple with the MegaCrimp® coupling insertion tool. Made of lightweight solid aluminum, and designed to mount either on top or on the side of a work bench, it has a slot for holding a marking pen or grease pencil. You simply locate the slot with the correct dash size, insert the hose and push it all the way in. Check to ensure the cut is square and then mark the insertion depth on the hose. Now you can easily see if the coupling is properly seated on the hose before you crimp. Ask your Gates representative for product no. 7482-1342.

Crimp Procedures

Listed here are crimp procedure basics. Always reference the operator's manual for instructions specific to individual crimpers. Also remember to wear safety glasses and to keep hands and clothing away from moving parts.

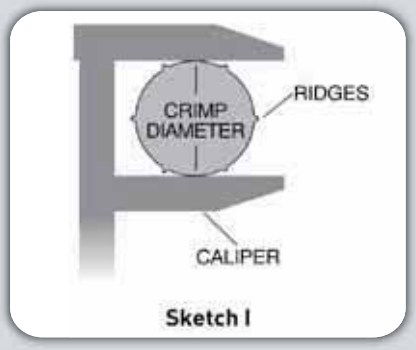
1. Refer to a crimp data chart for skive data, die selection, finished crimp diameter and approximate crimp setting.
2. Load the selected dies into the crimper. When using a die set for the first time, apply a thin coat of lubricant to the contact surface and cone but not to the bore of the die. This layer of lubricant must be thinly re-applied when contact surfaces become shiny. Locate dies in the crimp position.
3. Adjust the machine to the proper crimp setting.
4. Adjust the depth stop if necessary.
5. Insert the assembly, and locate it with the die fingers.
6. Install a die cone if needed.
7. Activate the crimp mechanism.
8. Remove the assembly from the dies, and measure the crimp diameter.

QUICK TIP:

Always check the crimp diameter to ensure that it is within the published limits. Record your actual crimper setting to achieve the specified crimp diameter for future use.

How to Properly Measure Crimp Diameter

1. *Measure halfway between the ridges. (See Sketch I.) When using dial calipers, be sure the caliper fingers do not touch the ridges.*
2. *Measure halfway down the crimped portion of the ferrule. (See Sketch II.)*
3. *When measuring small crimp diameters (3/16" and 1/4"), a set of jaw-type micrometers is recommended.*
4. *Do not measure the top of the code identification marks.*



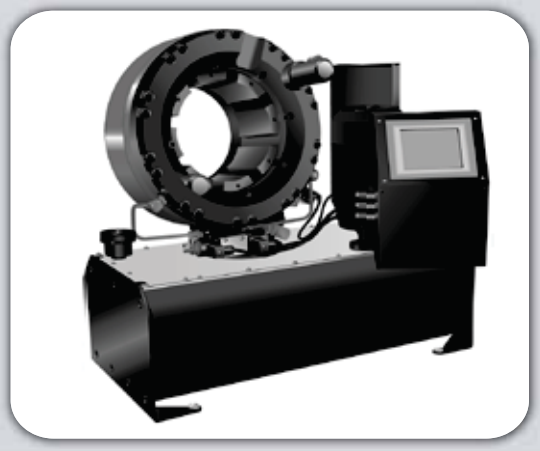
Sketch I

Sketch II

Note: If the actual crimp diameter is not within the recommended crimp tolerance, you may need to check the calibration of the machine and recalibrate.

GC96™ Crimper

Gates GC96™ crimper is your solution for making leak-free, factory-quality assembles. Crimp ¼" to 6" hose (with the exception of 2", 6-spiral hose), and use a touch pad screen to load Gates eCrimp settings and activate the crimper. Its horizontal front-end feed makes the process fast and easy. Ask your Gates representative about product 7480-9001.



Permanent Swage Procedures

Hose must be marked for proper insertion depth into the coupling. After checking the swage data chart for the right depth, lightweight oil is used to lubricate the inside diameter of the hose. The coupling hex is placed into a vise, and hose is inserted to the given depth.

The following are basic swage procedures, but it is always prudent to refer to an operator's manual for specifics.

1. Insert the correct die and pusher into the swaging machine.
2. Lubricate the inner bore surfaces of the dies with a thin film of lightweight oil.
3. Put the hose assembly through the dies, feeding the hose and coupling into the pusher.
4. Pull control lever while guiding the coupling into the die until the pusher bottoms against the top of the die surface.
5. Push the control lever to retract the pusher and open the die halves. Remove the swaged hose assembly.

QUICK TIP:

For safety's sake, use swagers only if you have received hands-on training. Always follow current operating manual instructions, use new hose and fittings and wear safety glasses.

Field Attachable

"Field attachable" means no crimper is needed to attach the couplings. Here are the basic steps in the assembly of field attachable couplings:

1. Thoroughly oil the hose and nipple.

2. Put the socket in the vise as shown. Turning counterclockwise, thread the hose into the socket until it bottoms on the inside shoulder of the socket. Then turn the hose back one-half turn.

3. In clockwise motion, thread the stem into the hose and socket until the stem hex shoulders against the ferrule.

Hose Cleanliness

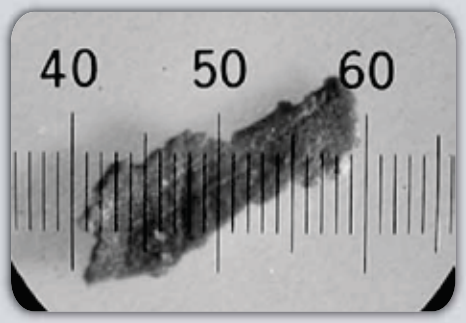
Contamination is generated during system operation, built into the system during assembly or ingested by the system during operation. It can affect valves, pumps and drives and system cooling, decreasing equipment life and causing expensive failures. That is why it is important to use clean components and assemblies and to monitor contamination levels.

QUICK TIP:

For optimum performance, the working fluid in hydraulic systems should be as homogeneous as possible and free of all visible and microscopic debris. Be sure to use clean hose and couplings, since the best approach to cleanliness is preventing contamination in the first place.

Methods of Contamination Measurement

Contamination particles are usually sized using a metric unit called a micrometer, otherwise known as a micron. A micron is equivalent to 39 millionths (.000039) of an inch, and the human eye can discern a particle no smaller than forty microns.



The International Standards Organization (ISO) has established these three principal methods to measure the contamination level within a component, circuit or system:

1. *Gravimetric Measurement (ISO 4405)*
2. *Particle Size Distribution (ISO 4406)*
3. *Maximum Particle Size Analysis (ISO 4407)*

Find details at ISO.org.

MegaClean™ System

The easiest method of cleaning a hose is to blow air through it, but that is really only a half-measure. To do the job thoroughly, Gates recommends using the Gates MegaClean™ system. Pressurized launchers and compatible nozzles blow foam projectiles through the inside surface of the hose, scrubbing away fine particles of loose dirt and contaminants. The projectiles are 20-30 percent larger than the hose ID and leave nothing behind but a clean hose.

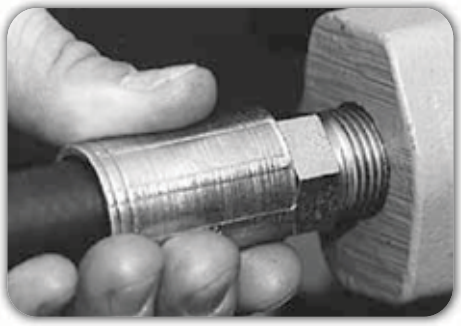
INSTALLATION

Installation procedures vary based on coupling configurations, adapters and routing, but it is always necessary to follow proper safety precautions.

Coupling Configurations

Male Fitting to Port Connections

Male fitting to port connections can be made using four types of configurations: solid male (MP, MB, MBSPT, etc.); male swivels (MPX, MBX, MIX); flanges (FL, FLH, FLC, FLK); and block-style adapters with lock nuts.



Solid male fittings are installed by rotating the entire hose assembly as you thread the male into the port. Teflon® tape can be used on the tapered threads to ease installation and improve the seal.

If an O-ring is used, it should be lubricated with oil before installation. A dry O-ring will stick and pull away from the sealing area resulting in a poor seal.

Once hand-tight, a wrench is used on the hex to properly torque the fitting. Since hose rotation is necessary, two solid males should never be used on the same hose assembly.

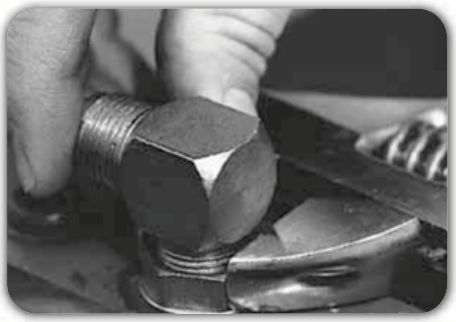
Male swivel installation does not require hose rotation. Simply thread the male into the port and use a wrench to torque properly. Since the hose does not rotate, you can orient the hose curvature to assist in routing. Be aware that male swivels (except MIX) have internal O-rings that must be compatible with the fluid used.

Flanges are installed using split flange clamps. Here are steps for proper flange fitting installation:

1. Put a small amount of oil on the O-ring and place it in the fitting groove.
2. Place the fitting over the port.

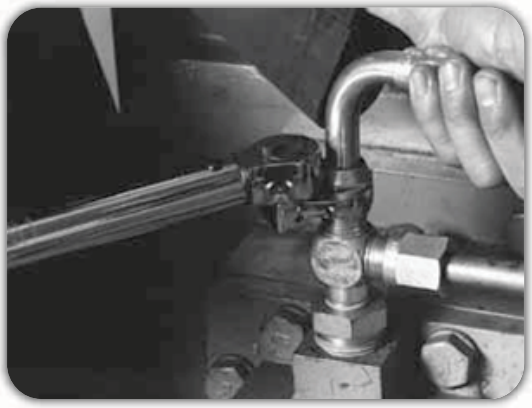
3. Install the clamp halves over the flange head and thread in bolts by hand.
4. Use a torque wrench to tighten using a crossing pattern.
5. Torque to the manufacturer's specifications.

Some block-style male port adapters use lock nuts to orient the fitting. Rotate the block and thread the fitting into the port. When nearly tight, hold the block in position and tighten the lock nut against the port.



Female Swivel Connections

Female swivel connections are made by rotating the swivel nut over the solid male threads. Never use a swivel female with a swivel male. Once hand-tight, use a wrench to hold the backup hex while tightening the swivel nut to proper torque. This will prevent stem rotation and hose twist.

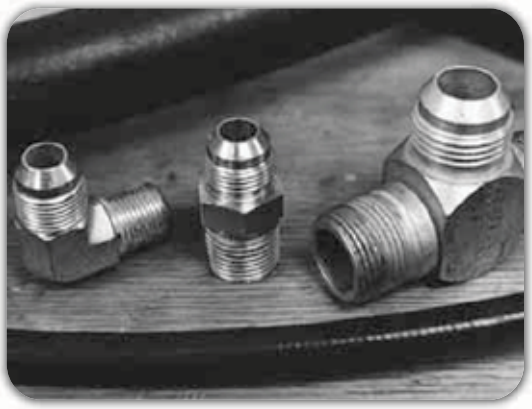


Bent tube and block-style fittings must be held in position by hand while tightening.

Compression-Style Fittings

Compression-style fittings (MSP, MFA, STA, ABC) use a bite sleeve and nut for connecting to tubing. Installation steps are as follows:

1. Make sure the tube is cut cleanly with no burrs or paint buildup.
2. Place the nut and then the bite sleeve over the tube. The bite sleeve must be oriented with the taper facing away from the tube.
3. Locate the tubing into the male fitting and secure the nut over the threads. The bite sleeve will compress against the tube and seal with the male internal taper.



Use of Adapters

Adapters can be used to make installation and orientation easier. Be aware, however, that adapters can also be a potential leak point. They can be used in the following situations:

1. To avoid fitting orientation, use a straight fitting and an angle adapter on one end. This makes installation easier and eliminates the need for orientation. However, this requires more parts and increases the number of joints for potential leakage.
2. When jump-size fittings are not available, make the jump with an adapter.
3. To ease port connection and hose installation.
4. To change to a different thread configuration, including international threads.

As a rule of thumb, it is better to use a straight adapter and bent tube coupling than an angled adapter and straight hose end. This promotes laminar flow and reduces pressure drop. When using adapters, the preferred method is to install the adapter first and the hose assembly next.

Hose Routing Tips

Many assemblies fail because of improper routing. To minimize damage caused by excessive flexing or whipping, all replacement hose should be restrained, protected or guided using clamps. Protective armor, spring guards or sleeves made of abrasion-, temperature- or chemical-resistant material will help protect hose from cuts, abrasions, corrosives or hot components.

Here are some hose routing tips that will prevent unnecessary assembly failures:

Length Change

When hose installation is straight, allow enough slack in hose line to provide for length changes that will occur when pressure is applied.

Movement/Flexing

Adequate hose length is necessary to distribute movement on flexing applications and to avoid abrasion.

Tight Bend

1. *When radius is below the required minimum, use an angle adapter to avoid sharp bends.*
2. *Use proper angle adapters to avoid tight bends in hose.*

Twist

1. *Prevent twisting and distortion by bending hose in same plane as the motion of the port to which hose is connected.*
2. *When installing hose, make sure it is not twisted. Pressure applied to a twisted hose can result in hose failure or loosening of connections.*
3. *Avoid twisting of hose lines bent in two planes by clamping hose at change of plane.*

Strain

Elbows and adapters should be used to relieve strain on the assembly and to provide neater installations which will be more accessible for inspection and maintenance.

Abrasion

Run hose in the installation so that it avoids rubbing and abrasion. Clamps are often required to support long hose runs or to keep hose away from moving parts. Use clamps of the correct size. A clamp too large allows hose to move inside the clamp, causing wear.

Collapse

To avoid hose collapse and flow restriction, keep hose bend radius as large as possible. Refer to hose specification tables for minimum bend radius.

High Heat

High ambient temperatures shorten hose life, so make sure hose is kept away from hot parts or use protective sleeving.

Reduce Connections

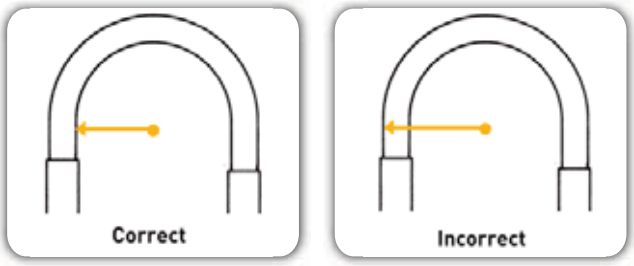
Reduce the number of pipe thread joints by using hydraulic adapters instead of pipe fittings.

Appearance

Route hose directly by using 45° and/or 90° adapters and fittings. Avoid excessive hose length to improve appearance.

Bend Radius

The minimum bend radius of a hose is 1/2 the smallest diameter the hose can be bent without internal damage or kinking. Most hydraulic hose manufacturers list the minimum bend radius for their hose, which is based on the hose construction, pressure rating, size and wall thickness. Bend radius is measured to the inside of the curvature as shown below.



Seven Easy Steps to Assembly Installation

1. *Clean the surrounding area where connections are to be made. Do not let dirt or contaminants into the opening.*
2. *If adapters are used, install them now.*
3. *Lay the hose assembly into the routing position to verify length and correct routing.*
4. *Thread one end of hose assembly onto the port or adapter. Install angled fitting first to ensure proper positioning.*
5. *Thread the other end of the assembly without twisting the hose. Use a wrench on the fitting's backup hex while tightening.*
6. *Properly torque both ends.*
7. *Run the hydraulic system under low pressure and inspect for leaks and potentially damaging contact points.*

Installation Torque

Installation torque is very important to ensure a proper leak-free seal. Overtorquing of a threaded connection can stretch and damage threads and mating seat angles. It can also damage the staking area of a nut or possibly break a bolt on the port area. Undertorquing does not allow proper sealing.

If a threaded connection leaks, maintenance personnel may be inclined to tighten the connection until the leak stops. This approach may solve the leak problem, but it also may cause more damage. Torque should first be checked before continued tightening to ensure it is within accepted limits.

The most reliable method of torquing threaded connections is to first hand-tighten the connection and then use a torque wrench to measure the torque.

Full-Torque Nut™ Couplings

Crack down on nut cracking, seat damage, leaks, corrosion and premature coupling failure in your hydraulic system. Available on MegaCrimp® couplings for wire-braid hose and GlobalSpiral® couplings for spiral-wire hose, Gates Full-Torque Nut™ has a large holding shoulder that evenly distributes stress forces for unsurpassed resistance to over-torquing and cracking.

Bundling

When installing hose assemblies, bundling techniques can improve space utilization, appearance and hose life. Here are some tips:

1. Group and bundle similarly constructed and sized hose together using clamps, nylon straps or nylon sleeving.
2. Never bundle high-pressure hose with low-pressure hose. Under pressure, they can work against each other.
3. Never bundle rubber hose with thermoplastic or Teflon® hose. Under pressure, they can also work against each other.

4. Always consider mechanical movement when bundling. Allow sufficient slack without pulling on a fitting or another hose. Bundles should bend in one plane only.

Sleeving

A number of sleeving types are used today. The most common is nylon, which is typically used to protect hoses from abrasion or for bundling hoses.

QUICK TIP:

Remember that most sleeving provides little or no operator protection. Use sound engineering judgment in the design of equipment in order to control the hazard of direct exposure of operators to fluids under pressure.

Spring Guards

There are many types of spring guards – flat armor, plated wire, plastic, etc. They can be used to bundle hose, provide stability or protect against abrasion. In addition, tightly wound plated wire guards can be used as bend restrictors to ease stress on the hose.

Bend Restrictors

Bend restrictors typically are PVC sleeves which are installed near the coupling during hose assembly. They reduce bending stress in the hose to prevent damage.

CONCLUSION

Once a hydraulic system has been installed and is operational, it is important to closely monitor how the equipment sounds and functions. Regular inspection helps ensure that equipment is running strong, raises red flags, and in the long run, saves the heavy costs incurred through downtime or equipment failure.

ADDITIONAL RESOURCES

For more Gates Fluid Power resources on safe hydraulics practices and preventive maintenance, visit www.gatesprograms.com/safehydraulics. Gates offers "Safe Hydraulics," a special hydraulic preventive maintenance training program designed to help maintenance managers, repair technicians and machine operators identify component weaknesses before failure. For more information, contact pa0000@gates.com. You will also find information on Gates hose, couplings, crimpers and accessories at www.gatesprograms.com/hydraulics.

PREVENTIVE MAINTENANCE FOR INDUSTRIAL & HYDRAULIC HOSE SYSTEMS

CHAPTER 4

Industrial Hose Preventive Maintenance

A solid preventive maintenance (PM) program is critical to the safe and productive operation of hydraulic and industrial hose systems. This multi-chapter Gates Fluid Power eBook delves into the many advantages gained by taking proper safety precautions and identifying system weaknesses before failure occurs.

Previous chapters have reviewed inspection and troubleshooting, hose and coupling selection and assembly and installation processes for hydraulic systems. In Chapter 4 we detail the various benefits and essential components of a preventive maintenance program for industrial hose systems.

THE IMPORTANCE OF PREVENTIVE MAINTENANCE

Preventive maintenance programs are a combination of *preventive* knowledge, from proper hose and coupling selection to proper coupling attachment, and *preventive* action, from periodic inspections and hydrostatic pressure testing to scheduled replacement and troubleshooting.

Following such a program is critical, as unexpected hose failure can damage equipment, stop production and even cause injury or death. The key is to identify and prevent potential problems before failure occurs by using the right hose for the application, replacing hose on a regular schedule (regardless of condition) and, of course, replacing hoses showing signs of deterioration or damage.

When care is taken, the benefits of a preventive maintenance program are clear. Costly repairs are eliminated, and production downtime is minimized. Hose life expectancy is increased, costly EPA spill cleanups are reduced and workers are kept safe.

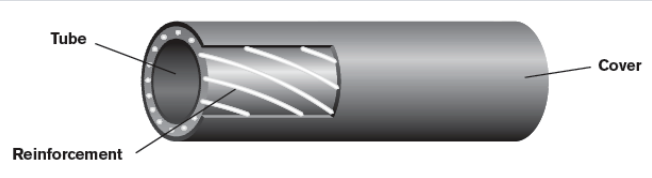
DEFINING INDUSTRIAL HOSE

An industrial hose is a flexible, reinforced tube used for conveying liquids, solids and gases. A typical industrial hose is dragged, coiled, run over, kinked and subjected to all kinds of wear and tear as well as abuse. It is critical that the application and its environment are taken into consideration for proper hose selection. Selection of the proper hose and materials will increase hose life, improve performance and ensure safety.

Industrial hose is used for three purposes:

1. To transfer gases, liquids, solids and mixtures of these materials.
2. As a flexible connector to absorb surges and vibrations.
3. As a conduit to protect other hoses, pipes and wires.

The Basic Elements of a Hose



Tube *– Its purpose is to handle specific fluids or solids. It is the innermost rubber or plastic component of the hose and must be resistant to the material being conveyed. A variety of compounds can be used depending on the application.*

Reinforcement *– Its purpose is to withstand a specific amount of working pressure measured in pounds per square inch (psi) or Pascal (Pa) or vacuum (In Hg, inches of mercury). The reinforcement may consist of multiple layers of fabric, yarn or wire placed on top of the tube and referred to as "plies."*

Cover *– Its primary purpose is to protect the tube and reinforcement from external factors such as ozone, weather, abrasion and heat. A variety of compounds can be used depending on the application.*

QUICK TIP:

Hose should not be used in "out-of-sight" applications where it is buried, encased or submerged. Use rigid pipe in these applications. Also, remember that hose has a finite service life and is not meant to be used in permanent applications.

HOSE SELECTION

Proper hose selection is the first step in preventive maintenance. Selecting the right product for the application will allow you to obtain the maximum life expectancy from the product for the most value.

When selecting hose, use the acronym STAMPED as your guide to defining important characteristics: Size, Temperature, Application, Material being conveyed, Pressure, End requirements and Delivery.

STAMPED

Here is a list of hose selection considerations for quick reference:

Size

- *I.D. (inside diameter)*
- *O.D. (outside diameter)*
- *Length*
- *Flow rate requirements (GPM for liquids; CFM for gases)*

Temperature

- *Ambient temperature*
- *Internal temperatures*
- *Temperature impact on material being conveyed*

Application

- *Where the hose will be used*
- *How the hose will be used*
- *How often the hose will be used*
- *Environmental conditions*
- *Special hose construction needs*
- *Conductivity requirements*
- *Critical applications (flammable fluids, compressed gas, steam, etc.)*
- *Government or industrial standard requirements*

Material Being Conveyed

- *Chemical name(s) and state(s)*
- *Food, pharmaceuticals, cosmetics*
- *Dry or powder*
- *Liquid*

Pressure

- *Working pressure*
- *Maximum surge pressure*
- *Vacuum*

End Requirements

- *Type of end connections/couplings*

Delivery

- *How many items and when they need to be supplied*
- *Special packaging or branding requirements*

Gates Industrial Hose

These Gates application-specific Industrial Hose moves food, fuel and other essentials from end to end:

- ***Acid chemical hoses** are flexible, lightweight and engineered to safely transfer the most corrosive substances.*
- ***Air and multi-purpose hoses** offer excellent flexibility and maximum resistance to weather and ozone while conveying air, water and other substances.*
- ***Food and beverage hoses** meet FDA sanitary requirements, resist abrasion and soiling on the outside and will not impart taste to food products.*
- ***Material handling hoses** come with an assortment of tube and cover materials that will handle the suction/discharge of dry commodities and liquids.*
- ***Petroleum transfer and dispensing hoses** for commercial gasoline, oils and other petroleum products are tough and easy to handle.*
- ***Steam transfer hoses** safely handle pressures up to 250 psi and temperatures up to 450°F, including superheated and saturated steam, wet or dry.*
- ***Water handling and dispensing hoses** provide superior water and light chemical service in industrial, construction, agriculture, mining and waste management applications.*

To learn more, download our Industrial Hose Products Catalog at [http://gatesprograms.com/hosesystems.](http://gatesprograms.com/hosesystems)

COUPLING SELECTION

Couplings must be selected to maximize the safety and performance of a system. The following criteria are considered in identifying which style is best for the application:

- Attachment options (ferrule, band or clamp)
- Availability of size
- Availability of required thread type
- Cost
- Coupling compatibility with conveyed material
- Quality
- Ease of handling

In critical applications, however, specific couplings are required. These include corrosive chemical transfer, LP gas, oil field drilling, petroleum products transfer, steam and ground fueling of aircraft. No substitutions should be made unless written authorization has been given by the hose manufacturer, coupling manufacturer and the end user for the specific application.

QUICK TIP:

The coupling end type must be of the same type as the port to which the hose is being attached.

STATIC ELECTRICITY GROUNDING

Movement of some dry material through a rubber or plastic hose can generate enough static electricity to be hazardous. Not only could a static spark ignite a fire or cause an explosion, but enough charge could build-up in the hose to cause a severe shock if contacted.

Grounding can be achieved through use of static conductive stock in the tube or cover, the bent wire method or the metal staple method.

The bent wire method is used with wire-reinforced hose. Follow these steps:

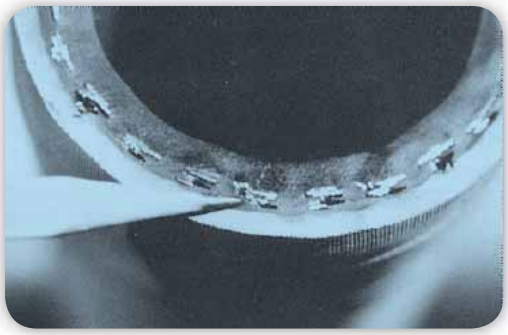
1. Locate the helix wire or the static wire.
2. Pull the wire out with pliers.
3. Bend the wire into the inner surface of the hose tube, using caution to not puncture the tube.
4. Attach the couplings so the bent wire and the coupling make contact. The bent wire must not extend the full length of the stem, since it could create a leak at the coupling.

5. Place the assembly on a non-conductive surface and check it for electrical continuity with an ohmmeter that measures electrical resistance. (The maximum allowable resistance is 20,000 ohms per foot of hose.)
6. Record all test data on a hose inspection card and file it with maintenance records.

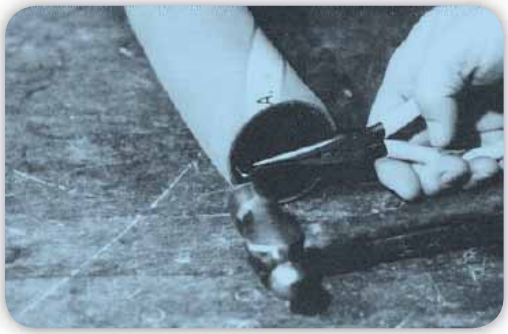
Hose assembly being tested with ohmmeter.

The metal staple method is used with a hose that has a carbon fiber static conductor or wire reinforcement where the staple can be inserted easily against a static conducting member. Follow these steps:

1. Cut the hose end square to the desired length.
2. Locate the static wire, wire braid or carbon fibers.
3. Place one leg of an aluminum, copper or stainless steel staple into the wire reinforcement or carbon fiber. (For acid chemical hoses use only stainless steel staples.)
4. Place the other leg of the staple inside the tube making sure the staple straddles the tube wall and is snug against the end cut.
5. Pinch the staple with pliers to force the leg against the inner surface of the tube wall.
6. Clean the staple and coupling shank ends with an emery cloth or steel wool.
7. Attach the coupling so the staple and coupling make contact.
8. Place the assembly on a non-conductive surface and check it for electrical continuity with an ohmmeter that measures electrical resistance. (The maximum allowable resistance is 20 thousand ohms per foot of hose.)
9. Record all test data on a hose inspection card and file it with maintenance records.



Close-up of hose end showing wire braid in hose.



Placing the staple.

Pinching the staple into the tube wall.

HOSE INSPECTION

Achieving hose safety and performance requires periodic inspections of the hose and fittings prior to, during and after use. Hoses that have become old, worn or damaged can present a danger to personnel and to the environment. Hoses that are not properly maintained can fail, which may result in costly material spills, cleanup, downtime and injury. Planned inspections, corrective actions and hose replacements can be less expensive than replacement or repairs made after a failure occurs. When and how should hose be inspected? Requirements will vary with each application type, but the following factors should be considered:

- Critical nature of application
- Operating temperatures
- Operating pressures
- Environmental factors

It might help to think of hose inspection at two levels. The first is an ongoing, daily inspection that includes looking for signs of hose cover damage, stiffness or hardness of the hose; changes in color; cover blisters; kinked or flattened hose; leakage and damaged hose reinforcement. The second level inspections are ideally conducted during regular equipment shutdown but should occur at least every three months. It includes a visual inspection for leakage, hydrostatic pressure testing and a close look at signs of physical change.

QUICK TIP:

Never inspect a hose for leaks by running your hand over it while it is under pressure or contains the material being transferred. Escaping fluid under pressure can exert enough force to cause severe injury, and hot materials and chemicals can cause serious burns.

HOSE HANDLING & MAINTENANCE TIPS

The following are top tips to ensure the long life of your hose, the efficiency of your system and the safety of your workers:

1. Never exceed the rated working pressure of a hose or allow pressure spikes or surges above its maximum rated working pressure. Excessive pressure can shorten the life of the hose.
2. Never run over a hose with equipment or vehicles, such as forklifts. Running over a hose can damage the tube, reinforcement and cover. A buildup of pressure can cause damage at the coupling.
3. Never pull a hose by its coupling. Pulling a hose at the coupling can kink the hose and weaken the coupling bond to the hose.
4. Never lift a heavy, large-diameter hose by the middle with the ends hanging down. The internal reinforcement can be damaged at the support point. Support large hose every ten feet with rope saddles or slings. When moving a hose, always lift the hose and coupling together, and use dollies, rollers or derricks when moving large hoses.
5. Never over-bend a hose to the point of kinking or bend it tighter than the recommended minimum bend radius. Never kink a hose to stop the flow of material, as this can seriously damage the tube and reinforcement. If needed, install bend restrictors at the coupling to prevent the hose from being bent past the minimum bend radius.
6. A hose cover exposed to excessive wear can be protected with an extra cover, such as a nylon sleeve or pad. Make the cover slightly longer than the hose to accommodate any change in the hose length when in use.
7. Remove kinked or crushed hose from service immediately. Inspect and test the hose before putting it back in service. An outside diameter of a hose which has been permanently reduced by more than 20 percent should be removed from service. An outside diameter of a hose which has been reduced by 20 percent or less should have a hydrostatic test done before being put back into service.
8. Remove and test any hose assembly that has been subjected to abuse. This includes hose that has been severely pulled at the coupling, flattened, crushed, kinked, cut, abraded or exposed to temperatures or pressures above noted maximums.
9. Visually inspect and pressure test hose at regular intervals. This is extremely important for critical application hoses, such as acid/chemical, steam, LPG and petroleum. Check for kinks, bulges, soft spots, loose areas, abrasions and cuts. Cuts or abrasions which expose the reinforcement are signs that the hose should be immediately removed from service.
10. Always check for fluid seepage by pushing at the base of the coupling with your thumbs; a hose softened by fluid seepage must be replaced. Check for coupling slippage, and remove any hose that does not pass your visual inspection.

HOSE CLEANING TIPS

There are many different methods used to clean hose assemblies. An apron, safety glasses or face shield, rubber boots and gloves should be worn to help protect personnel from potential injury. Some suggested cleaning methods for select hoses are listed below. Which method to use, and how often cleaning should be performed, is based on the following:

- Type of hose
- Residual material in the hose
- Cleanliness requirements for the application
- Cleaning facilities available
- Consideration for disposal of the residual material and cleaning solutions
- Requirements for special applications such as foods and pharmaceuticals

Solution Recommendations

1. Cleaning solutions should dissolve or remove residual material without damaging the hose assembly.
2. A dilute solution of soap in water can often be sufficient. Some chemicals, such as concentrated acids or bases, can react with water releasing heat and byproducts and possibly splatter.
3. Consult the MSDS of the material being cleaned to identify potential cleaning solutions.
4. After identifying potential cleaning solutions, check for compatibility with the hose tube and cover. Noncompatibility of a cleaning solution can cause damage to the hose.

Flushing or Immersing in a Cleaning Bath

1. Do not exceed the maximum working pressure or temperature for the hose.
2. The cover of the hose should also be washed or wiped to remove any residual material.

Steam Cleaning

1. Steam cleaning is generally not recommended. High temperatures can accelerate aging of a hose and shorten service life.
2. Do not exceed the maximum temperature rating of the hose. Doing so can cause defects such as tube delamination (reducing tube-to-reinforcement adhesion), tube cracking or tube "thin spots."
3. Never use superheated steam. This will exaggerate the potential damages noted above. Only "open end" 50 psi steam should be used.
4. If the hose has a blockage, remove it before introducing steam.
5. If the steam source has a wand attached, use caution inserting the wand so that physical damage to the hose is not caused. Sharp edges on the wand can cut the tube, and thin spots could occur where the hot wand contacts the tube.

Shuttle Method

This method, which uses a shuttle to travel through the inside of a hose assembly to wipe residual material from the hose, is not recommended. The shuttle and residual material can come out of the hose at velocities that could cause injuries or damage. There is also danger from a buildup of pressure if the shuttle becomes lodged. The shuttle can cause damage to the hose tube.

Cleaning of Chemical/Food Hose

1. Drain the hose after each use.
2. Flush with water or another (neutralizing) cleaning solution.
3. Properly dispose of drained fluid and cleaning waste.
4. Between uses, store the hose in a clean, dry environment away from sunlight.
5. Avoid cross contamination. Dedicate a hose to handle each specific material.

HOSE STORAGE TIPS

1. Store hose in a cool, dry room with moderate humidity. Temperatures between 50°F to 75°F are preferred. Do not exceed 100°F.
2. Store hose out of direct sunlight and away from heat sources.
3. Keep hose away from ozone sources such as arc welders, electric motors, transformers and other electrical equipment.
4. Store hose in original shipping container or wrapping to protect from harmful environmental exposure.
5. Hose shipped straight should be stored straight.
6. Use care when using knives or sharp tools to open packing materials.
7. Hose shipped in coils or bales should be stored on a horizontal plane.
8. Hose should be stored in a first-in, first-out basis.
9. Do not hang coiled hose on a hook.
10. Do not stack hose too high. Excessive weight can crush and damage the hose at the bottom.

RMA Hydrostatic Testing Procedures

All hose and couplings should be hydrostatic tested at regular intervals.
Here is an outline of the general procedure:

1. *The hose should be at room temperature.*
2. *The testing area should be clean and dry.*
3. *Lay the hose out straight to its full length.*
4. *Place the hose on rollers. This allows the hose to be moved while under pressure.*
5. *Restrain the hose if there is danger of uncontrolled movement during the test.*
6. *Conduct a visual inspection. Look for cuts, gouges, bulges, soft spots, coupling slippage or any other signs of wear.*
7. *A hose which does not pass a visual inspection should be replaced.*
8. *A hose which does pass a visual inspection is then connected to a test pump and the free end is fitted with a quick-opening valve.*
9. *Elevate the free end and fill the hose with water from the pump. Always use water. Never test with flammable or corrosive fluids, solvents or compressed gas.*
10. *As the hose fills with water, bleed the air out through the open valve. Close the valve and lower it to the ground when all the air is out.*
11. *RMA has testing literature available for each hose type. It is imperative to pressure test the hose at the proper pressure.*
12. *Drain the hose and allow it to dry before returning it to service.*

TROUBLESHOOTING

The following guide reviews common problems found in hydraulic assemblies and offers possible solutions:

Problems	Causes	Solutions
Hose burst in one or more places along the length of the hose.	Exceeded the rated working pressure. Hose twisted during attachment to ports during application, causing gaps in the reinforcement.	Check pressure output of system. Use a hose with a higher pressure rating. Use swivel couplings.
Hose tube swells or deteriorates, blocking material flow or causing a leak.	Hose tube is not compatible with material being conveyed and/or temperature.	Identify the material and the temperature at which the system operates. Refer to the Gates Chemical Resistance Table or contact Hose Product Application in Denver at 303-744-5070 for assistance.

Problems	Causes	Solutions
Hose tube becomes hard, cracks and leaks; may appear charred.	Excessive heat can leach out plasticizers in the tube. Air or aerated oil can cause oxidation of rubber that is accelerated by heat.	Select a hose with a higher temperature rating. Look at ways to reduce system temperature and aeration of oil.
Cracks in hose tube and cover result in a leak; yet tube and cover are soft and pliable at room temperature.	Flexing of hose during a period of extreme cold when the tube and cover were too stiff.	Check lowest internal and external temperatures, especially at the time of equipment startup. If possible, use a hose that will remain flexible below the lowest operating temperature of the application.
Coupling blows off end of hose when pressurized.	Incorrect coupling used; hose was not fully inserted into the coupling; not correctly skived at coupling attachment end or coupling not crimped to specified diameter (too loose or too tight).	Check hose and coupling compatibility. Review crimp specifications and procedure. Make sure routing does not impart excessive stresses to the hose assembly.
Hose inner tube collapsed inward, folded and a portion is often torn away.	Hose not designed for high vacuum. Adhesion between tube and reinforcement may be poor. The hose may have been bent too sharply and kinked.	Use a hose designed for high vacuum. Check routing to avoid exceeding the minimum bend radius.
Hose burst on the outside of the bend and burst hole is elliptical in shape.	Hose bent too tight in routing causing the reinforcement to open up too much on outside of bend.	Check routing. Do not exceed rated minimum bend radius. Consider using bent tube couplings, adapters or bend restrictors to relieve stress on the hose.
Hose pulls out of the coupling.	Hose when pressurized shortens up, pulling out of coupling. Hose not supported with the added weight of the material, pulls out of the coupling.	Check routing for proper hose length. Allow some slack to compensate for hose movement when pressurized. Support long lengths of hose with clamps, cables, etc. Do not use hose as a rope or cable.
Hose flattened in one or more areas.	Hose twisted, kinked or run over. Extreme twisting and kinking can open up large gaps in the reinforcement allowing a blowout to occur.	Check routing. Use swivel couplings to prevent twisting the hose when making port attachments. Use bent tube couplings and longer lengths of hose to avoid excessive bending and kinking. Use crush resistant hose as a rope or cable.
Wire reinforcement is rusty at site of hose burst.	Hose cover was damaged from cuts, abrasion, extreme temperatures, chemical attack, internal gases diffusing through the tube and collecting under the cover forming blisters which break, or improper skiving and coupling attachment.	Protect hose against cuts and abrasion with a nylon sleeve or steel coil guard. Check temperature and chemical compatibility rating of hose tube and cover with the application. Consider pin pricking the cover of the hose to allow diffused gas to escape and not become trapped under the cover.

Problems	Causes	Solutions
Hose leaks profusely without bursting.	High velocity erosion of hose inner tube. Fluid velocity in general may be too high.	Consider a larger diameter hose to handle the volume flow at a lower velocity.
Hose leaks or bursts. Cover is deteriorated, hard, has fine cracks and feels stiff.	Hose maturity causes loss of performance properties and eventually fails from the effects of environmental conditions such as heat, cold, ozone and sunlight.	Check the code date on the lay line of the hose, generally, anything beyond five to seven years of age is questionable. Suggest a maintenance replacement schedule that meets the application conditions.
Hose tube worn through on one side and leaks.	Abrasive material wore through the tube.	Select hose with a thicker and/or more abrasion resistant tube. Periodically rotate hose to even out abrasion wear. Use a larger diameter hose to reduce material velocity. Do not bend hose as severely.
Hose burst at end of coupling.	Exceeded maximum rated working pressure. Hose bent sharply over the end of the coupling. Did not follow the recommended coupling attachment procedure.	Use a higher pressure rated hose. Use hose bend restrictors and do not exceed the minimum bend radius rating. Check the coupling used and crimp diameter.
Hose cover blistered; blisters filled with material being conveyed.	Hose not compatible with material being transferred.	Select a hose with a tube having a high compatibility rating with the material being transferred.
Hose cover blistered; blisters not filled with material being conveyed.	Gas in liquid. High pressure causing high rate of gas permeation of tube.	Remove gas from line. Pin prick hose cover. Change to a hose with a tube of higher density/lower porosity.
Cover of hose soft, gummy, discolored and worn away by friction.	Hose cover not compatible with material and/or temperature.	Select a hose cover that is compatible with the material and temperature.
Discharge pressure/volume too low.	Pump output capacity too low. Hose or coupling restriction.	Increase pump output. Check for hose kinks. Increase hose and/or coupling inside diameter. Add “booster pump” if hose length is extremely long.

CONCLUSION

The safest, most efficient industrial hose systems are backed by strong preventive maintenance programs. A critical first step is selecting the right, application-specific hose, and beyond that, maintenance managers should prepare for any possibility – from hazardous levels of static electricity to leakage or damage. The best approach to preventing failure or another costly outcome is being proactive in inspecting, maintaining and troubleshooting industrial hose systems.

ADDITIONAL RESOURCES

For additional Gates Fluid Power resources related to industrial hose systems, including a white paper, product catalog and brochures, visit http://gatesprograms.com/hosesystems. Visit http://gatesprograms.com/hydraulics for hydraulic system resources. Contact pa0000@gates.com if you have any questions about Gates Fluid Power products and services.