



PREVENTIVE MAINTENANCE FOR INDUSTRIAL & HYDRAULIC HOSE SYSTEMS

CHAPTER 1

Hydraulic Preventive Maintenance: Establishing a Program

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 will delve into the many advantages gained by taking proper safety precautions and identifying system weaknesses before failure occurs. It will also take a step-by-step approach to hose and coupling selection, assembly, installation and troubleshooting.

This initial chapter focuses on hydraulic assemblies, introducing the reasons for establishing a PM program and outlining the necessary steps – from inspection to troubleshooting – to keep safe systems running at maximum efficiency.

PREVENTIVE MAINTENANCE AS A NECESSITY

Even in the toughest economic climate, no business should cut corners when it comes to preventive maintenance. Avoiding costly emergency repairs, production downtime and compromised worker safety is strong incentive for following careful maintenance plans.

The main objective of a PM program is to identify component weaknesses before failure and loss of production. In the case of hydraulics, high pressures and temperatures make hose and fitting maintenance, as well as component selection, particularly important.



BENEFITS OF PREVENTIVE MAINTENANCE

From cost savings to protecting workers, every organization has much to gain from a solid preventive maintenance program. Here are some examples:

- **Efficient production**, since equipment is in prime operating condition.
- **Better use of in-shop maintenance personnel** with less emergency work.
- **Improved control** of spare parts inventory and reduced parts usage.
- **Less equipment downtime** through scheduled inspections.
- **Safety hazards** are minimized.
- **Increased life expectancy** of equipment.
- **Fewer capital outlays** for premature purchases of new equipment.
- **Reduced repair costs** from fewer breakdowns.

COMPONENTS OF A PM PROGRAM

An effective PM program includes these key elements:

- Maintaining a safe work environment.
- Maintenance records.
- Regularly scheduled inspections.
- Troubleshooting.
- Proper hose and fitting selection.
- Proper assembly, routing and installation.
- Periodic maintenance and product training.

SAFETY

Although establishing and maintaining a safe work environment might seem like common sense, refreshing associates and employees on the basics will help lessen the risk of catastrophic outcomes.

Pressure, temperature, flammability, mechanical parts and electricity are all factors to consider when working with hydraulic equipment.

QUICK TIP:

Society of Automotive Engineers (SAE) recommended practice J1273 contains many useful suggestions about design, installation, maintenance and other activities involving hose assemblies in hydraulic systems.

Pressure

Operating pressures of hydraulic systems reach as high as 10,000 psi. With hydraulic fluid under pressure, the following dangers are encountered:

- **Pinhole.** Fluid escaping from a pinhole can be virtually invisible and yet cause serious injury. Workers must avoid touching and even approaching any part of a pres-

surized hydraulic system. Serious emergencies arise and medical attention is needed when fluid punctures the skin, even if no pain is felt.

- **Leak.** Leaking hydraulic fluid is not only unsightly, it is hazardous. It makes workplace floors slippery and dangerous and can also contaminate the environment. In fact, as little as one quart of oil can pollute up to 250,000 gallons of water, and it is estimated that 100 million gallons of oil leak from hydraulic equipment annually.

QUICK TIP:

Before cleaning an oil spill, always check EPA, state and local regulations.

- **Burst.** Whether due to improper selection or damage, a ruptured hose can cause injury. If it bursts, a worker can be burned, cut or injected or may slip and fall.
- **Coupling Blowoff.** If an assembly isn't properly made or installed, the coupling could come off and hit or spray a worker, possibly resulting in serious injury.
- **Whipping Hose.** If the hose end or end fitting comes apart under pressure, the loose hose can whip around with great force. This has the potential to cause serious injury. If this hazard exists, the hose should be restrained or shielded using clamps or protective shielding.
- **Stored Energy.** Hydraulic systems sometimes use accumulators to store potential energy or absorb shock. This energy can create pressure that keeps a system's components moving.

QUICK TIP:

Charged accumulators can be lethal. Always open the accumulator's valve to release pressure.

Pascal on Pressure

Blaise Pascal, the French scientist and philosopher, was the first to discover that a pressure applied to any part of a confined fluid transmits to every other part with no loss. The pressure acts with equal force on all equal areas of the confining walls and perpendicular to the walls. Pascal's studies centered on the principles of hydraulic fluids led him to invent the hydraulic press and the syringe.

Dose, Duration & Manner of Contact

As a federal public health agency of the U.S. Department of Health and Human Services, the Agency for Toxic Substances and Disease Registry (ATSDR) notes that many factors determine whether one is harmed when exposed to hydraulic fluids. These include the dose, duration of exposure and the manner in which one comes into contact with it.

Temperature

Most hydraulic systems operate between 150° and 180°F, but some go as high as 300°F. Liquid at these temperatures, as well as metal parts, can cause burns.

Flammability

With the exception of those comprised primarily of water, all hydraulic fluids are flammable when exposed to the proper conditions. Leaking pressurized hydraulic fluids may develop a mist or fine spray that can flash or explode upon contact with a source of ignition. Precautions should be taken to eliminate ignition sources, including electrical sparks, open flames, extremely high temperatures, and hot manifolds and engine blocks.

Mechanical

Swinging arms, booms, rollers, presses and anything that moves can be dangerous if a hose fails. For example, when a hose bursts, objects supported by fluid pressure may fall, and vehicles or machines may lose their brakes.

QUICK TIP:

If equipment is mobile, always chock the tires to prevent rolling.

Electrical

Hydraulic equipment must be turned off before it is worked on. With plant equipment, the control box should be locked and it should be tagged with a warning sign. With mobile equipment, the key should be removed and/or the battery should be disconnected so that it cannot be started.

High-voltage power lines and underground power sources must be identified before equipment is run. OSHA standards require that all hydraulic tools used on or near energized power lines or equipment are supplied with non-conducting hose having adequate strength for normal operating pressures [29 CFR 1926.951(f)(3)].

LifeGuard™ Lives Up to Its Name: The Sleeve Protects Against Hydraulic Hose Failure

A pinhole leak in a hydraulic hose under pressure can have catastrophic effects – threatening life and limb. That is why those working with hydraulic equipment seek out new ways to protect against toxic fluids under pressure.

Pole tampers, protective hoses and ordinary nylon sleeving simply do not offer the level of safety needed when lives are at risk. The LifeGuard™ Line-of-Sight Sleeving System from Gates Corporation is an unprecedented product, containing 6,000 psi bursts and 3,000 psi pinhole leaks on -four (1/4 inch), -six (3/8 inch) and -eight (1/2 inch) hose sizes up to 212°F.



Compatible with a wide range of fluids, from environmentally friendly liquids to biodiesel fuel, the double-layer Life-

Guard sleeving protects workers within a three-foot line-of-sight of a hydraulic system. Its inner layer is made of tightly woven, extruded filament nylon designed to absorb the energy of a hydraulic hose burst or pinhole leak by stretching up to 20 percent. The outer sleeve, which is resistant to abrasion but not specifically designed for abrasive environments, is a bolt-cut, air-textured nylon material that contains escaped fluids and redirects them to the clamped ends of the hose.

The sleeve is secured at either end of the hose with special “channel” clamps. The clamps allow leaking fluid to safely escape, so it will not collect behind the sleeve and cause a burst. Plus, leaked fluid allows for fast hose failure detection.

LifeGuard sleeving has been subjected to rigorous testing programs – in the lab and in the field – to offer a true safety solution. Visit www.gates.com/lifeguard to learn more.

In addition to the factors above, proper hose selection, coupling selection, hose assembly and installation are all critical to ensuring the safe operation of hydraulic systems. These topics will be covered in depth in following chapters of this eBook.

INSPECTION

Hydraulic equipment should be monitored during normal operation, as any noticeable difference in how it sounds, looks or feels often indicates a problem. In addition, periodic inspections ensure that systems are running safely and efficiently.

When to Inspect

Recommended inspection schedules vary by type of equipment, so operating manuals should be referenced. That noted, here are some basic guidelines:

- Mobile equipment should be inspected every 400-600 hours or every three months, whichever occurs first.
- Stationary equipment should be inspected every three months.
- The critical nature of the equipment, operating temperatures, operating pressures, environmental factors, type of usage and the accessibility of the equipment all influence how often hose should be inspected.

QUICK TIP:

Look for opportunities to inspect and correct potential trouble spots like high heat sources, rough abrasion areas and tight bends or twisting.

Inspection Procedure

The following is an outline to help maintain hydraulic hose efficiently and safely:

1. Turn off equipment power and release pressure from the accumulators. Lock the control box, and tag it with a warning sign that reads, "DOWN FOR MAINTENANCE. DO NOT TURN ON POWER." With mobile equipment, turn the key off, put it in a safe place and disconnect the battery.
2. Place equipment and components in a safe or neutral position. Make sure components are not in mid-stroke, in mid-cycle or holding a load. Before working around the equipment, drop the load, retract cylinders, relieve pressure and allow cool-down time.
3. Remove access panels and inspect hose and fittings for damage or leaks. Check the cover for signs of

abrasion, blisters, nicks, cracks, cuts, hardness or color changes. Determine what is causing the damage. When inspecting for leaks, look for puddles of fluid around the equipment, low fluid levels in the reservoir or greasy/dirty hose. Proper hose routing is critical in preventing early hose failure. Make sure hoses do not rub against each other or metal parts. Also check that they are not located near a high heat source. Check for twisting or kinking, and make sure there is enough slack to allow for length changes under pressure.

QUICK TIP:

Never check for leaks by running your hand over hose or hydraulic connections. Instead, use a piece of cardboard to locate a pressurized leak. For drips, use a rag to clean the area and determine where the leak originates.

4. Repair or replace hose assemblies as needed.
 5. Inspect other hydraulic components. Look beyond hose and fittings to valves, pumps and cylinders for leaks and damage.
 6. Reinstall the access panels.
 7. Turn on the power.
 8. Be aware of your equipment. Your eyes, ears and nose are your best inspection tools. If something seems off, inspect further to avoid hose assembly failure.
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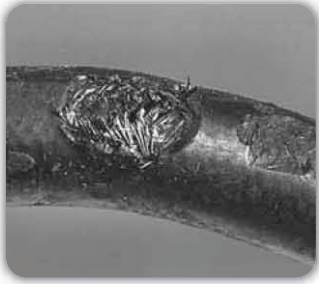
QUICK TIP:

Is your hose hot to the touch?
If you can't hold it for five seconds, the operating temperature may be too high.

[Keeping a detailed log of inspection and service information helps identify problem areas and monitor maintenance trends.](#)

TROUBLESHOOTING

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



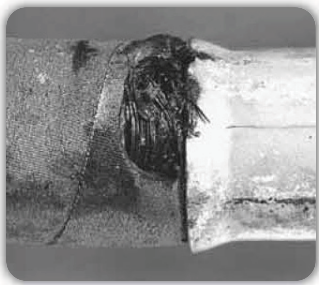
Problem: [Hose Abrasion](#)

Solution: Reroute the hose to keep it away from abrasive sources or guard the hose with a protective sleeve.



Problem: [Hose Burst Away from Hose Ends](#)

Solution: Inspect system operating pressure and select a hose that meets or exceeds the system's maximum pressure. Try rerouting the hose to prevent excessive flexing or keep the hose from exceeding its minimum bend radius.



Problem: [Hose Burst at Coupling](#)

Solution: Increase the hose assembly's length to accommodate contraction under pressure; increase the hose bend radius or install bend restrictors; or replace the hose assembly with a properly crimped assembly.



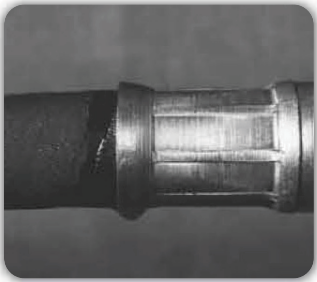
Problem: [Leak at Thread End/Seat](#)

Solution: Remove the connection and inspect.

1. Certain couplings require the use of an O-ring. If it's missing, replace it. If an O-ring is used, check for damage caused during installation or possible material breakdown from heat or fluid incompatibility. Alternative O-ring materials may be required. Replace if necessary.
2. Check the threads and/or seat angle on both mating surfaces for damage that may have occurred prior to or during installation. Any ding or burr may be a potential leak path. Replace if necessary.

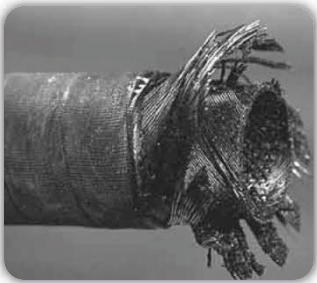
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3. If the coupling was misaligned during installation, threads may have been damaged. Replace and carefully install.
4. It is possible to thread together some components that are not compatible. Use Gates thread I.D. kit to assist in identifying mating components. Some thread end configurations have better sealability than others. Also, ensure proper coupling selection.
5. Over-torquing of a threaded connection can damage threads and mating seat angles. Over-torquing can also damage the staking area of the nut causing cracking of either the nut or seat. Under-torquing does not allow proper sealing. Use of a torque wrench can alleviate such problems.



Problem: Weep/Seep at Hose Coupling Interface

Solution: Whether it has been undercrimped or the stem has been improperly inserted, the hose assembly must be replaced with one that has been properly assembled.



Problem: Coupling Blow-Off

Solution: Examine and replace the hose assembly to ensure proper assembly procedures are followed. Modify hose length and/or routing to accommodate potential hose length reduction under pressure. Never mix different manufacturers' hose, couplings or crimpers.



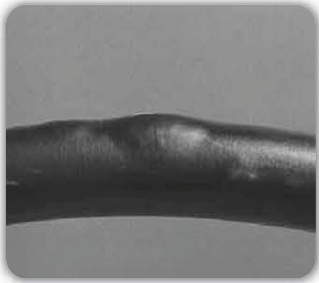
Problem: Hose Cracks

Solution: Select a hose that meets the temperature and flow requirements of the application. Also, identify the heat source and consider rerouting it away from the source to minimize the effects. Examine reservoir size (if necessary).



Problem: Hose Twist

Solution: Replace and reroute the hose to ensure that bending occurs only in one plane. The use of bent tube or block style couplings and adapters may improve routing. Also, when installing the assembly, hold the backup hex to prevent it from turning and applying a twist. If male and female couplings are used on the same hose assembly, install the male (non-swivel) end first.



Problem: Cover Blisters

Solution: Replace the hose with one that is recommended as compatible with the fluid being used. If it is compressed gas, the cover can also be perforated (pin-pricked) to allow the gas to seep through the cover. Textile hose covers also eliminate blistering. Bleed the system to eliminate any trapped air.

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](mailto: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 2

Hydraulic Preventive Maintenance: Hose & Coupling Selection

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.

Improperly matched or coupled hose will likely fail, causing downtime and possible personal injury. In this chapter, we outline criteria for selecting the right hose and couplings for safe and efficient hydraulic assemblies.

RIGID TUBING VS. HOSE ASSEMBLIES

There are two common types of fluid connection — rigid tubing and hose assemblies. Their respective advantages are compared in this table:

RIGID TUBING	HOSE ASSEMBLIES
• Better heat dissipation	• Less susceptible to damage from vibration or movement
• Tighter bend radius	• No brazing or specialized bending requirement
• Lighter weight	• Easier to obtain in the aftermarket
• Ability to handle pressures over 6,000 psi	• Sound absorption
	• Dampens pressure surges

While bent tubing has offered a weight advantage and tighter bend radius, recent advancements in hydraulic hose have made it lighter and created improved bend radius. In addition, the wide availability and routing advantages of hose have made it a popular option for maintenance personnel in replacing hard-to-reach failed tubing.

HOSE CONSTRUCTION

In choosing the proper hose for an application and for the purposes of replacement, it is important to consider the three components of a typical hydraulic hose:

- **Tube:** As the innermost layer, the tube's function is to contain the material conveyed.
- **Reinforcement:** The reinforcement is the hose's muscle. It provides the necessary strength to resist internal pressure (or external pressure in the case of suction/vacuum). The three basic types of reinforcement are braided, spiraled and helical.
- **Cover:** The cover protects the reinforcement and tube from environmental conditions including weather, ozone, abrasion, temperature and chemicals.

Types of Reinforcement



Braided reinforcement can be wire or textile and have single or multiple layers.

Spiraled reinforcement is typically wire or textile and has four or six layers. Spiral-reinforced hose can typically handle more severe applications with longer impulse service life.

Helical coil reinforcement keeps the hose from collapsing during suction/vacuum and tight bending.

QUICK TIP:

Think about the life of your equipment and the safety of its operators. Never use hoses to pull external loads or to replace ropes or cables.

HOSE PERFORMANCE CHARACTERISTICS

The life of hydraulic hose and hose assemblies are dependent on service conditions. Subjecting hose and hose assemblies to conditions more severe than the recommended limits significantly reduces service life. Plus, exposure to combinations of recommended limits, such as continuous use at maximum rated working pressure, maximum recommended operating temperature or minimum bend radius, also reduces service life.

QUICK TIP:

Hose assemblies in service should be regularly inspected for leaks, abrasion, kinks, cover blisters or other such damage. And assemblies showing signs of wear or damage should be replaced immediately.

Maximum service life can be attained by complying with the following recommendations:

Working Pressure

The hydraulic system pressure should not exceed the rated working pressure of the hose. Pressure surges or peaks exceeding the rated working pressure are destructive and must be taken into account when selecting a hose. It is not safe to use hose assemblies above their rated working pressure.

Minimum Burst Pressure

Burst pressures are reference pressures intended for destructive testing purposes and design safety factors only.

Temperature Range

Hose should not be exposed to internal or external temperatures exceeding the recommended limits. Consult additional technical data when hydraulic fluids contain emulsions or solutions. The fluid manufacturer's recommended maximum operating temperature for any given fluid must not be exceeded, regardless of hose temperature range. Some fluids reduce the safe operating temperature of a hose (i.e. water in a hydraulic hose).

Fluid Compatibility

The hydraulic assembly (tube, cover, reinforcement and couplings) must be fluid compatible. The correct hose must be used since phosphate ester and petroleum-based hydraulic fluids have drastically different chemical characteristics. Many hoses are compatible with one or the other but not all fluids.

Minimum Bend Radius

Do not bend or flex hose to a radius smaller than the minimum recommended, and do not subject hose to tension or torque. This can place excessive stress on the reinforcement and severely reduce the ability of the hose to withstand pressure.

Hose Size

The hose size (inside diameter) must be capable of handling the required flow volume. A hose I.D. too small for a given flow volume results in excessive fluid turbulence, pressure drop, heat generation and tube damage. It is generally a best practice not to exceed 30 feet per second fluid velocity in a hydraulic system. Using a larger I.D. hose will lower fluid velocity.

Hose Routing

Use clamps to restrain, protect or guide hose to minimize risk of damage due to excessive flexing, whipping or contact with other moving parts or corrosives. Determine hose lengths and configurations that will result in proper

routing and protection from abrasion, snagging or kinking and provide leak-resistant connections.

Hose Length

Correct hose length determinations include considerations for length changes under pressure, machine vibration and motion, as well as hose assembly routing.

Hose Applications

Select the proper hose for the application. Vacuum service and special fluid or high temperature capabilities are among the applications requiring particular consideration and a specific hose.

HOSE SELECTION

To take into account the hose performance characteristics and the demands of a particular application, a simple and easy method is used to properly select hydraulic hose: STAMPED.

STAMPED

S = Size

T = Temperature

A = Application

M = Material to be conveyed

P = Pressure

E = Ends or couplings

D = Delivery (volume)

Size

The inside diameter of the hose must be adequate to keep pressure loss to a minimum and avoid damage to the hose due to heat generation by excessive turbulence. Velocity of hydraulic fluid in suction lines should always fall within a specific range recommended to ensure efficient pump operation.

To determine the replacement hose size, read the layline printing on the side of the original hose. If the original hose layline is painted over or worn off, the original hose must be cut and inside diameter measured for size.

QUICK TIP:

Before cutting an original hose assembly, measure the overall assembly length and coupling orientation. This measurement will be required to build the replacement assembly or match the hose I.D. to the port size.

Hose O.D. should not be used to identify the I.D. of the hose. Different hose constructions will vary with the wall thickness and O.D.

The hydraulics industry has adopted a measuring system called Dash Numbers to indicate hose and coupling size. The number that precedes the hose or coupling description is the dash size. This industry standard number denotes hose I.D. in sixteenths of an inch. (Exceptions are SAE100R5, SAE100R14 and refrigerant hoses, where dash sizes denote hose I.D. compared to equivalent tube O.D.)

Hose O.D. can be a critical factor when hose routing clamps are used or when hose is routed through bulkheads. Check the manufacturer's individual hose specification tables for O.D.s.

Temperature

When selecting a replacement assembly, two areas of temperature must be considered. These are fluid temperature and ambient temperature. The hose selected must be capable of withstanding the minimum and maximum temperatures of the system. Care must be taken when routing hose near hot manifolds, and in extreme cases, a heat shield is advisable.

QUICK TIP:

To avoid equipment breakdown and possible injury, the fluid manufacturer's recommended maximum operating temperature for any given fluid must not be exceeded. If it is different from the listed hose temperatures, the lower limit must take precedence.

Actual service life at temperatures approaching the recommended limit will depend on the particular application and the fluid being used in the hose. Intermittent (up to 10 percent of operating time) refers to momentary temperature surges. Detrimental effects increase with increased exposure to elevated temperatures.

Application

Determine where or how the replacement hose or assembly is to be used. Most often, only a duplicate of the original hose will have to be made, provided the original hose assembly gave acceptable service life.

To fulfill the requirements of the application, additional questions may need to be answered, such as the following:

- Where will the hose be used?
- What type of equipment is this?
- What are the working and surge pressures?
- Is this a suction application?
- What are the fluid and ambient temperatures?
- Have I considered fluid compatibility?
- What are the environmental conditions?
- What are the routing requirements?
- Are government and industry standards being met?
- Am I contending with unusual mechanical loads?
- What hose construction will work best?
- What thread end connection type should I use?
- What thread type is right?
- Should I use permanent or field attachable couplings?
- What is the minimum bend radius?
- Is non-conductive hose required?
- Will there be excessive abrasion?
- What is the expected service life?

Material to Be Conveyed

Some applications require specialized oils or chemicals to be conveyed through the system. Hose selection must ensure compatibility of the hose tube, cover, couplings and O-rings with the fluid used. Additional caution must be exercised in hose selection for gaseous applications where permeation can occur.

Permeation, or effusion, is seepage through the hose resulting in loss of fluid. This may occur when hose is used with fluids including these:

- Liquid and gas fuels
- Refrigerants
- Helium
- Fuel oil
- Natural gas

Consider whether there are potential hazardous effects of

permeation through the hose, such as explosions, fires and toxicity. Refer to applicable standards for specific applications such as fuels and refrigerants. If gas permeates through the tube, consider pin-perforated covers to prevent gas build-up under the cover. Also consider the compatibility of the system fluid not only with the tube but also with the braid, cover, fittings and other components since permeation may expose the entire hose assembly to the system fluid.

Pressure

It is essential in the hose selection process to know the system pressure, including pressure spikes. Published working pressures of the hose must be equal to or greater than the system pressure. Pressure spikes greater than the published working pressure shorten hose life.

Burst pressures are reference pressures intended for destructive testing purposes and design safety factors only. Typically, for dynamic hydraulic applications, the minimum burst pressure rating is four times that of the maximum working pressure rating.

What Is Pressure Drop?

Pressure drop is the difference between the pressure of a fluid as it enters one end of a hydraulic hose assembly and the pressure of that fluid as it leaves the other end.

Here are some factors that can influence the amount of pressure drop:

- **Friction:** *This is the rubbing of fluid against the inside walls of the hose assembly.*
- **Viscosity:** *Different fluids behave differently under pressure. Thicker fluids are moved with greater difficulty and will exhibit greater pressure drop.*
- **Fluid Temperature:** *Warming fluids thins them so they are moved more easily, as with automotive oil.*
- **Length of Hose Assembly:** *The longer it is, the more surface there is for friction to decrease pressure.*
- **Size (I.D.) of Hose:** *Size affects the fluid velocity for a given flow rate. Higher velocities result in greater pressure drop. Therefore, a larger I.D. hose will produce less pressure drop.*
- **Couplings and Adapters:** *Any change in bore or change in direction (such as with 45° or 90° elbows) can increase the amount of pressure drop.*
- **Flow Rate:** *Pressure drop increases with flow rate for the same size hose.*

Ends or Couplings

Identifying the proper end connectors, the hose barb end and the port connecting end for a hose assembly is critical. Find details in the “Coupling Selection” section of this chapter.

Delivery

The amount of fluid that must pass through a hose determines the size of hose needed. Undersizing a hose leads to increased pressure loss, while oversizing the hose adds unnecessary cost, weight and bulk.

SAE

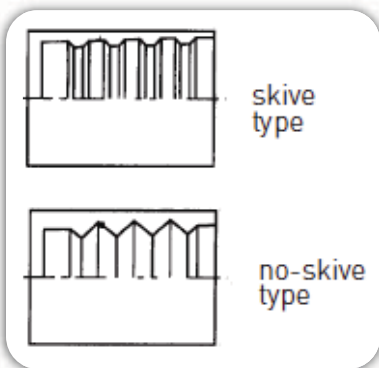
The Society of Automotive Engineers (SAE) establishes the American standards for most hydraulic hose. SAE guidelines provide general properties of size, tolerances and minimum performance characteristics of each major hose type. SAE-rated hoses from different manufacturers are not exactly the same but tend to be similar. SAE documents are available through SAE Customer Service at 724-776-4970.

COUPLING SELECTION

There are two types of hydraulic couplings – permanent and field attachable.

Permanent couplings require crimping or swaging equipment to assemble to a hose. They are available in either preassembled or two-piece configurations. Preassembled couplings are made with the ferrule permanently attached to the stem. Two-piece couplings consist of a stem and separate ferrule. When using two-piece couplings, it is important to match the ferrule with its appropriate stem and hose.

There are also two types of ferrules – skive and no-skive.



Skive ferrules have blunt serrations (teeth), while serrations on no-skive are sharp to bite through the hose cover.

None of these components – hose, stem or ferrule – is reusable once it's been part of another assembly.

QUICK TIP:

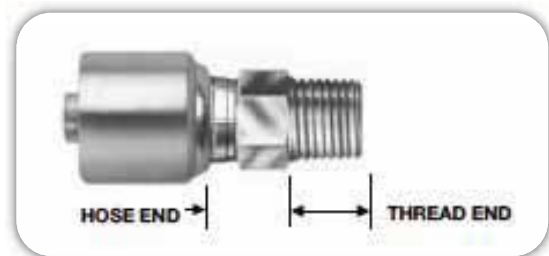
Never mix couplings and hoses from different manufacturers, and never recrimp or recouple used hose with permanent or field attachable couplings.

Finally, there are also different types of field attachable fittings – skive, no-skive, mandrel type, lock-on, C5 and those that are stamped for Department of Transportation use.

Coupling Identification

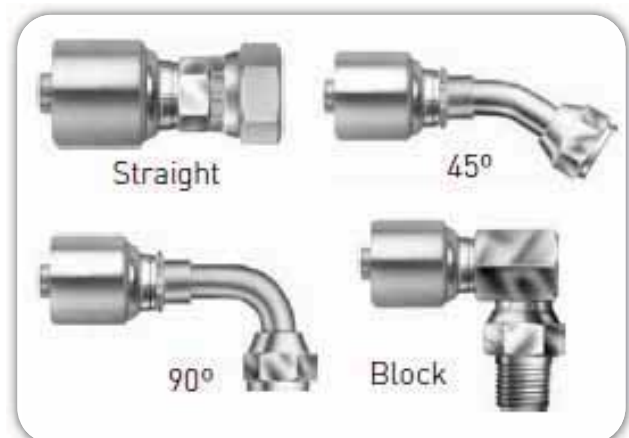
A hydraulic coupling stem consists of two functional ends:

1. The hose end for hose attachment.
2. The thread end for port attachment.



The hose end is identified by the hose size and type to which it is attached. Serration patterns are specified by the hose manufacturer to meet hose performance.

The thread end of a coupling (or adapter) can be identified by comparing it with the coupling being replaced or by measuring the port or thread end to which it will be attached. The thread end may also come in different configurations.

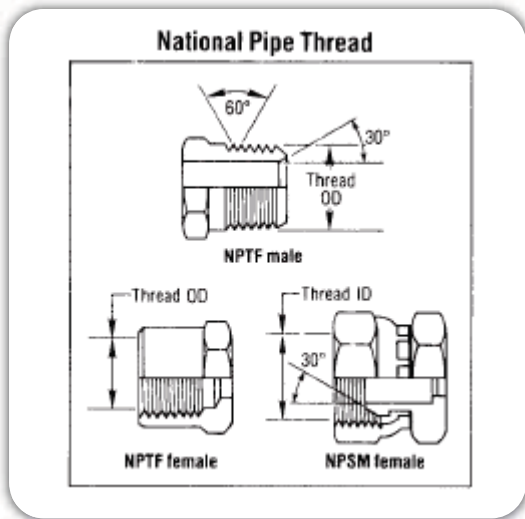


North American Standards

Listed below are the common North American hydraulic thread types. While all these couplings are widely used in the U.S. and Canada, they are also found on a worldwide basis in a variety of applications.

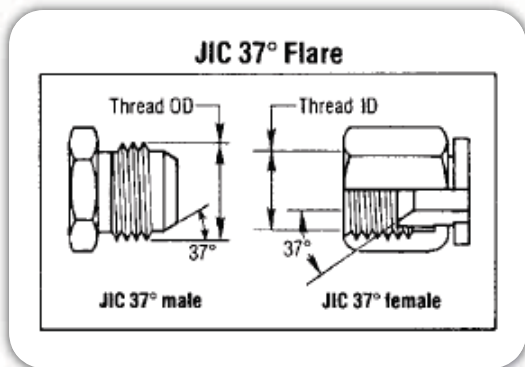
National Pipe Thread

These threads are available in several varieties: National Pipe Tapered for Fuels (NPTF), National Pipe Straight for Fuels (NPSF) and National Pipe Straight for Mechanical Joints (NPSM). The NPTF male coupling will mate with the NPTF, NPSF or NPSM female coupling.



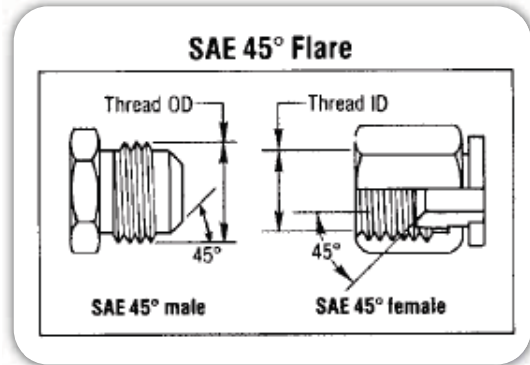
JIC 37° Flare

The Joint Industrial Conference (JIC) is now defunct, and this standard is included as a part of SAE J516. The JIC 37° flare male coupling will mate with a JIC female only. The JIC male and female have straight threads and a 37° flare seat. The seal is made on the 37° flare seat. Some sizes have the same threads as the SAE 45° flare. Carefully measure the seat angle to differentiate between the two.



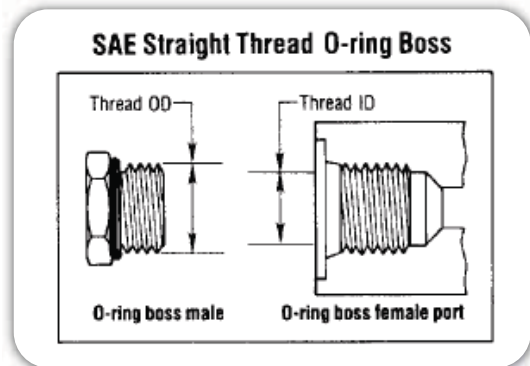
SAE 45° Flare

The SAE 45° flare will only mate with a SAE 45° flare female. Both male and female couplings have straight threads and a 45° flare seat. The seal is made on the 45° flare seat. Once again, because some sizes of this coupling have the same threads as the JIC 37° flare, carefully measure the seat angle to identify the correct coupling.



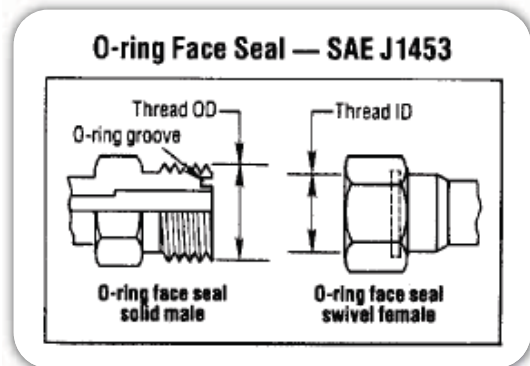
SAE Straight Thread O-ring Boss

The O-ring boss male will only mate with an O-ring boss female, and the female is generally found on ports. The male has straight threads and an O-ring. The female has straight threads and a sealing face. The seal is made at the O-ring on the male and the sealing face on the female.



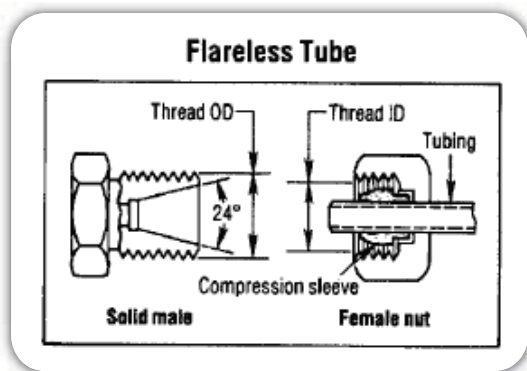
O-ring Face Seal

The solid male O-ring face seal fitting will mate with a swivel female O-ring face seal only. An O-ring rests in the O-ring groove in the male coupling. The seal is made when the O-ring in the male contacts the flat face on the female coupling.



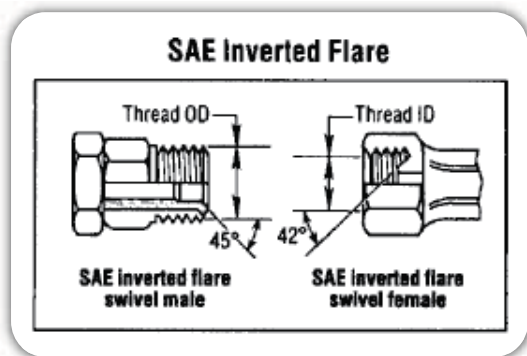
Flareless Tube

The flareless solid male only mates with a female flareless nut and compression sleeve. The male has straight threads and a 24° seat. The female has straight threads and a compression sleeve for a sealing surface. The seal is made between the compression sleeve and the 24° seat on the male and between the compression sleeve and the tubing on the female.



SAE Inverted Flare

The SAE 45° inverted flare male will only mate with an SAE 42° inverted flare female. The male has straight threads and a 45° inverted flare. The female has straight threads and a 42° inverted flare. The seal is made on the 45° flare seat on the male and the 42° flare seat on the female.

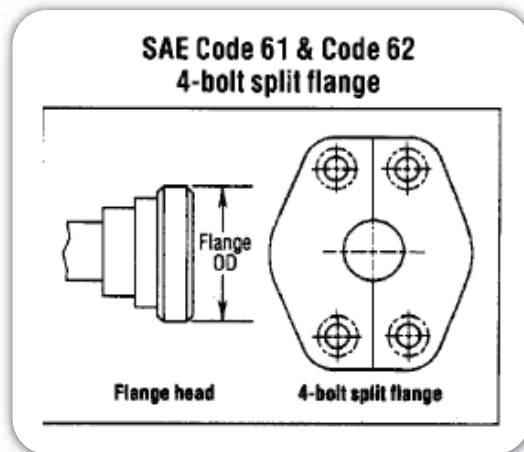


SAE Code 61 and Code 62 Flanges

These two couplings are used worldwide, usually as a connection on pumps and motors for extremely high pressure lines. There are four exceptions:

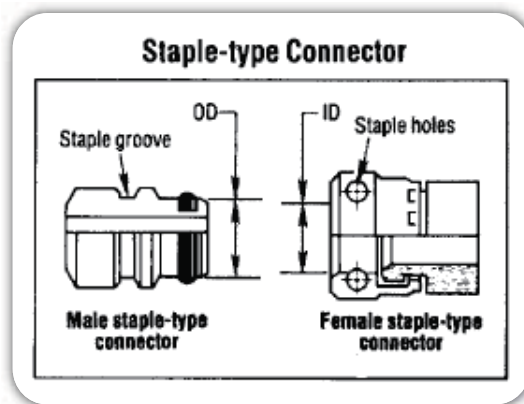
- The dash 10 size, which is common outside of North America, is not an SAE standard size.
- Caterpillar flanges, which have the same flange O.D. as SAE Code 62, have a thicker flange head and require different flange halves, clamps and bolts.
- Poclain flanges are completely different from SAE flanges and are not interchangeable with them.

- Komatsu flanges are dimensionally the same as SAE flanges except for their O-ring grooves.



Staple-Type

The seal on these connectors is made when the O-ring on the male contacts the inside surface of the female. The two connectors are held together with a staple. Staple-type couplings are commonly found on mining equipment worldwide.



International Thread Ends

As the volume and types of machinery imported into the United States grow, and the marketplace becomes more global, it is important to be aware of the differences between domestic and foreign couplings and to be able to identify each.

Knowing the country of origin for a piece of equipment provides a clue as to what type of thread end is used. Deutsche Industrial Norme (DIN) fittings indicate a German or Swedish manufacturer, while BSP is found on British equipment.

QUICK TIP:

International thread ends can be metric, measured in millimeters, but also include British Standard Pipe (BSP) threads, measured in inches.

Japanese Komatsu machinery uses Komatsu fittings with metric threads, while other Japanese equipment mostly uses Japanese Industrial Standard (JIS) BSP threads, or in some cases, BSP straight or tapered threads.

These criteria help correctly identify couplings:

- **Seat:** Inverted (BSPP & DIN), regular (JIS & Komatsu) or flat (flange, flat-face)
- **Seat Angle:** 30° (JIS, BSP, DIN and Komatsu) or 12° (DIN)
- **Threads:** Metric (DIN or Komatsu), BSP (BSPP, BSPT or JIS) or tapered (BSPT or JIS tapered)

What is critical is that the coupling or hose interface is compatible with the hose selected. The hose manufacturer's coupling recommendations should be followed, and the proper mating thread must be selected so that leak-free sealing is ensured.

Additional Selection Criteria

It is important to keep in mind that the hose assembly is only one component of a larger system. In choosing the correct end terminations for the couplings attached to the hose, formal design standards and sound engineering judgment should be used.

In the absence of formal design standards, an engineer should consider the following factors in choosing the proper end termination:

- Pressure
- Temperature
- Impulse frequency, amplitude and wave form
- Vibration
- Corrosion
- Dissimilar metals (galvanic corrosion)
- Maintenance procedures and frequency
- Installation reliability
- The connection's risk in the system
- Exposure to the elements
- The operator and bystander's exposure to the connection
- Installation, operation and service activities and practices that affect safety

Here is a closer look at some examples of how these criteria apply:

Pressure

Working pressure should be considered when selecting a fitting. Some fittings don't seal well at high pressures and can develop a leak. O-ring-type fittings as well as solid port connectors work well at high pressures. Avoid the use of swivel staked nut couplings at extremely high pressures.

Vibration

Coupling selection may be influenced if the end connection has quite a bit of motion and/or vibration, which can potentially weaken or loosen a connection. Use of split flange couplings, or other couplings that use an O-ring for sealing, perform better under vibration. Avoid use of couplings that seal on the threads.

Temperature

Metal surfaces can expand and contract under extreme temperature fluctuations. Choose couplings that use O-rings for sealing. The O-ring will seal as the metal moves. It may be necessary to use O-ring materials that are suitable for high temperatures. Also, use a fitting material that is best suited for the application's temperature (e.g. if the application is high temperature, avoid using brass or aluminum).

CONCLUSION

Suppliers offer hundreds of types and styles of hydraulic hoses, and thousands of different couplings and fittings. From corrosion resistance to fluid compatibility, each of the system's requirements must be carefully considered in the hose and coupling selection process. As always, matching parts from the same manufacturer for an integrated systems approach helps ensure that assemblies will perform above and beyond industry standards.

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](mailto:contact_pa0000@gates.com). You will also find information on Gates hose, couplings, crimpers and accessories at www.gatesprograms.com/hydraulics.