Among the basic components of every hydraulic system is a series of hoses and couplings that transport fluid under pressure from a pump to an actuating mechanism that converts the fluid into motion or force.

In a way, hoses and couplings are a critical sub-system of the larger hydraulic circuit that includes the fluid, reservoir, hydraulic pump, hydraulic valves and the actuator.

**Match hoses, couplings, crimpers**

Suppliers offer hundreds of different types and styles of hydraulic hoses, and thousands of different couplings and fittings. When selecting an OE hydraulic hose and coupling system or fabricating an aftermarket assembly, the first step must be to match hoses and couplings from the same manufacturer.

Gates Corporation and the Society of Automotive Engineers (SAE) recommend against using couplings from one manufacturer and hoses from a different manufacturer interchangeably. Although most American-made hydraulic hoses, and many imported hoses, are built to confirm to SAE specifications, SAE allows a wide range of materials to be used.

Different manufacturers use different materials that can result in a variety of hose styles. They design their hose and coupling components to fit their own tolerances. Hoses from various manufacturers may have similar dimensions and constructions, but different rubber compounds and reinforcement materials. Couplings are individually designed and tested to handle the hose manufacturer’s unique product. Also, the proliferation of thread ends from around the world in recent years has dramatically increased the possibility of mismatching threads and seats on various couplings.

To complete the hydraulic assembly system process it’s important that hose fabricators follow the assembly recommendations, and use the crimping equipment of the hose and coupling manufacturer. An improperly matched or coupled hose will likely fail, causing downtime and possible personal injury.
Hose selection
Several critical details must be considered when choosing the hose component of a hydraulic assembly system:

1. Correct size – both inside diameter (ID) and length.
2. Adequate rated working pressure.
3. A tube stock designed to handle the conveyed products.
4. A cover stock to resist the environment.
5. Adequate reinforcement to withstand crushing, pinching, extreme suction and other forms of abuse.
6. A coupling recommended for the hose that resists the fluid being conveyed.
7. Temperature of the material conveyed and cleaning method used on the hose.

Correct size
Most American-made hydraulic hoses, and many imported hoses, are built to conform to SAE specifications that provide specific requirements concerning size, tolerances, construction and minimum performance characteristics of each major hose type. SAE documents are available through SAE Customer Service at 412-776-4841.

The SAE J517 standard provides general, dimensional and performance specifications for 100R series hoses, which are the most common hoses used in hydraulic systems on mobile and stationary equipment. (See “SAE Hose Constructions”).

Over the past several years, some manufacturers have developed products that far exceed the performance and construction capabilities of SAE specifications. These include higher pressure and temperature capability, greater flexibility, along with the ability to bend twice as tight as standard hoses.

In order to select the proper hose size for an application, it’s important to determine the correct inside and outside hose diameters using a plug gauge, as well as the length of the hose.

Designers must adequately size the inside diameter of a hose to minimize pressure loss and turbulence. Turbulent conditions reduce efficiency and generate heat that can damage the hose. Hose manufacturers’ nomographic charts can help engineers size hoses for given hydraulic conditions.

Fluid velocity should not exceed the values shown in the charts. Higher velocities in pressure lines are generally acceptable for short durations however; fluid velocity in suction lines should always fall within the recommended range to ensure efficient pump operation.
When replacing a used hose assembly, read the layline printing on the side of the original hose to determine size. If the layline is painted over or worn off, cut the old hose and measure the ID. Prior to cutting, measure the overall length and coupling orientation. This will make it easier to build a replacement and match the couplings to mating ports.

Do not use outside diameter to identify the hose ID. Exceptions to this numbering system are SAE100R5, 100R14, and refrigerant hoses where dash sizes denote hose OD and are comparable to equivalent metal-tube.

Hoses vary with the wall thickness and hose outside diameter (OD), even though ID may be the same. Here, it is best to check individual hose specifications. Check individual hose specification tables for outer diameters in suppliers’ catalogs.

When replacing a hose assembly, always cut the hose the same length as the one being removed. Too long a hose can lead to it being severed or pinched in the moving components of the equipment. If the hose is too short, pressure may cause it to contract and be stretched, leading to reduced service life.

Changes in hose length when pressurized can range between +2 to -4 percent when hydraulic mechanisms are in operation. As a result, it is important to allow for possible shortening of the hose during operation by making the hose lengths slightly longer than the actual distance between the two connections. Typically, if a hose does gain slightly in length when in service, it does not cause the problems that a shorter hose might encounter.

Hoses that meet or exceed SAE performance specs but are smaller than standard hose can be good choices. Thanks to better materials, “hybrid hoses” have thinner tubes and covers, smaller diameter wire reinforcement, and more aggressive braid-reinforcement angles. The result: hoses with the same ID but smaller OD, making them more flexible and 10 to 15% lighter than earlier-generation products.

Today, leading manufacturers offer spiral-wire and wire-braid hoses with minimum bend radii one-third that of SAE specifications, reducing the overall length of curved assemblies and cutting costs by as much as 60%.
For example, Gates Corporation’s MegaSys® product line includes nine constant-pressure hydraulic hoses that have the smallest bend radius of any SAE-equivalent hose in the industry. The Gates spiral-wire and wire-braid hoses can be bent up to one-third the SAE specification, thereby saving overall hose assembly length and cost by as much as 64 percent.

Hoses that are more compact and flexible:
- Are easier to install and route in tight applications.
- Require fewer bent-tube fittings.
- Reduce inventory.
- Extend life in bending, flexing applications.

Pressure Capabilities
Most important in the hose system selection process is knowing system pressure, including pressure spikes. Hose working pressure must always be selected so that it is greater than or equal to the maximum system pressure, including pressure spikes. Pressure spikes greater than the published working pressure of the hose will shorten hose life and must be taken into consideration when choosing a hose for the hose system application.

In situations where equipment has been modified to perform special operations, it is not uncommon to see spikes in hydraulic pressure that the hose and coupling manufacturer did not anticipate. As a general rule, when choosing hose to transmit fluid under pressure, it’s best to allow a generous margin of safety. Typically, for dynamic hydraulic applications, the minimum burst pressure rating is four times that of the maximum working pressure rating.

It also is important to allow for pressure drop that occurs 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. The following factors can affect the amount of pressure drop:

- **Friction** – The rubbing of fluid against the inside walls of a hose assembly, especially at hose bends, can reduce flow rates.
- **Viscosity** – The lower the viscosity of the fluid, the more difficult it is to convey.
- **Fluid Temperature** – Elevated temperatures thin a hydraulic fluid so it flows more easily throughout the system.
- **Hose ID** – Size affects the fluid velocity for the given flow rate. Higher velocities result in greater pressure drop. Therefore, a larger ID 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.
Pressure drop also affects heat gain and the Reynolds Number. A high pressure drop, increases heat, which equates to horsepower loss. The Reynolds Number relates to flow:

Reynolds No. <= 2,000 = Laminar Flow
Reynolds No. > 2,000 and < 3,000 = Transient Flow
Reynolds No. >= 3,000 = Turbulent Flow

When designing a hydraulic hose and coupling system that requires a specified pressure (psi) of output for equipment to run efficiently, it is important to allow for pressure drop. If the system pressure is 4,000 psi and the pressure drop is 150 psi, for example, the system output pressure that will provide work will be at 3,850 psi. Help in determining pressure drop is available from representatives of hose and coupling manufacturers. Be prepared to describe the type of application, fluid type and viscosity, fluid and ambient temperature, fluid flow rate, hose size and length, routing requirements, required government and industry standards and the number and type of fittings.

Tube, cover stocks
Hose selection must assure compatibility of the hose tube, cover, couplings and O-rings with the fluid used. The characteristics shown in Table 1 are for the normal or usual range of specific hose stocks. Also, consult the hose manufacturer’s chemical resistance tables to determine hose compatibility.

Most hydraulic fluids are petroleum-based. Others include water-based, water glycols, and synthetic-based fluids such as phosphate esters. In the past, hydraulic-fluid leaks have sometimes contaminated soil and fouled water supplies. As a result, the industry is moving toward more environmentally friendly fluids.

“Green” fluids are typically synthetic (primarily ester-based) or vegetable-based. Vegetable oils are gaining popularity because they cost less and are more biodegradable than synthetics. They also have excellent lubricity and a high viscosity index. The downside is their limited temperature range and rapid oxidation at elevated temperatures. And although the base fluid may be biodegradable and non-toxic, the additives may not be.

Biodegradable fluids might be great for the environment, but they’re tough on hoses. They permeate ordinary hose tubes, causing cover blisters and sweating/wetness on the cover of the hose. The result is premature and expensive hose failure.
Most manufacturers utilize a nitrile tube for environmentally safe hydraulic fluids. Nitrile is tough enough to handle aggressive biodegradable fluids like synthetic esters, polyglycols, and vegetable oils at operating temperatures to 250°F. Plus, nitrile permits significantly less permeation than neoprene tubes when used with petroleum-based oils. (Permeation, or effusion, is seepage through the tube and hose, resulting in fluid loss.)

Because permeation may expose the entire hose assembly to fluid, check compatibility not only with the tube, but with the reinforcement, cover, fittings, and seals. The same holds for assemblies that convey special oils or chemicals.

Exercise additional caution selecting hose for gaseous applications subject to permeation. Some fluids that raise concerns include: liquid and gas fuels, refrigerants, helium, fuel oil, and natural gas. If gas permeates through the tube, consider pin-perforated covers to prevent gas build-up. Don’t neglect the potentially hazardous effects of permeation, such as explosions, fires, and toxicity. Refer to applicable standards for specific precautions involving fuels and refrigerants.

**Hybrid Hose stocks**

Tube and cover stocks may be upgraded to enhance performance. The hybridization of rubber and synthetic thermoplastic compounds into abrasion-resistant hydraulic hose offers a number of enhancements over traditional hose materials such as neoprene and nitrile.

A primary cause of hose failure on fluid power equipment is cover abrasions (pictured) resulting from cuts, friction caused by other moving parts or from mechanical impacts. On stationary equipment, for example, hoses can change in length while hydraulic mechanisms are in operation, causing a buffeting action to occur and exposing the hose reinforcement. Exposed hose reinforcement is susceptible to rust and accelerated damage leading to failure.

Hybridized covers made of thermoplastics have a very slick surface with a coefficient of friction just under that of Teflon™. The result is a cleaner appearing cover that resists dirt and oil residues.

Abrasion-resistant hose covers have been tested and found to last up to 300 times longer than standard rubber covers. This feature increases service life, lowers maintenance and eliminates the need for costly hose protectors such as guards, sleeves and bundling.

Also under development are elastomeric tubing compounds that are more readily compatible with a new generation of environmentally friendly hydraulic fluids and additives.
Choose the Right Connections
The amount and types of machinery being imported into the United States is growing dramatically as the marketplace becomes more global. The primary difference between a conventional SAE coupling and a foreign coupling is the thread configuration and seat angle.

Gates engineers assert that it is important to be aware of these differences and be able to correctly identify all the different types of couplings. Manufacturers and distributors offer manuals and tables to accomplish this task.

International thread ends can be metric, measured in millimeters, but also include British Standard Pipe (BSP) threads, which are measured in inches. Knowing the country of origin for a piece of equipment will provide 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. Japanese Komatsu machinery uses Komatsu fittings with metric threads, while other Japanese equipment most likely uses Japanese Industrial Standard (JIS) BSP threads, or, in some cases, BSP straight or tapered threads.

Three determinations are required for correct identification of these 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).

The coupling or hose interface must be compatible with the hose that is selected. Follow the hose manufacturer’s coupling recommendations only. The proper mating thread end must be selected so that proper leak free sealing can be made to mating components.

Coupling selection may be affected if the end connection has a high degree of motion, vibration or both. Use of split flange couplings, or other fittings that use an O-ring for sealing, perform better under vibrations. Couplings that use O-rings also are preferred on applications that are under extreme temperature fluctuations.
As stated earlier, avoid using couplings and hoses from different manufacturers interchangeably. Different manufacturers use different materials, which can result in a variety of tube styles. SAE allows a whole range of materials. An improperly matched or coupled hose will likely fail causing downtime and possible personal injury. So it’s important to follow only the crimp and assembly recommendations of the manufacturer of the products being used.

Temperature Considerations
Fluid temperature and ambient temperature must be considered when selecting both hose and couplings. The hose and couplings must be capable of withstanding the minimum and maximum temperature of the system.

Hoses are rated with a maximum working temperature that can range from 200°F to 400°F (93°C to 204°C). This depends on both the hose materials and the fluid temperature. Using a hydraulic hose at a temperature of 18°F above maximum rated temperature of the hose will decrease the hose life at least in half. Failure to use hydraulic oil with the proper viscosity to hold up under high temperatures can accelerate this problem.

Always follow the manufacturer’s temperature recommendations. Depending on materials used, hose temperatures may range from -65°F (Hytrel and winterized rubber compounds) to +400°F (Teflon®).

When hoses are exposed to high external and internal temperatures concurrently, there will be a considerable reduction in hose service life. Insulating sleeves can help protect hose from hot equipment parts and other high temperature sources that are potentially hazardous. In these situations, an additional barrier is usually required to shield fluid from a possible source of ignition.

Minimum Bend Radius
Subjecting a hose to a bend radius smaller than the minimum recommendation places excessive stress on the reinforcement, opens larger gaps between strands of reinforcement and severely reduces the ability of the hose to withstand pressure, thereby reducing hose assembly life. Also, hose bends immediately behind the couplings result in undue stress at the couplings. This is a very common cause of hose failures.

Gates suggests that if the bend must be sharper than the minimum radius, adapters or angle fittings should be used. The hose manufacturer’s specifications should be checked to determine the straight hose section, between the couplings, needed for a particular ID As a rule of thumb, a 1/4-inch ID hose requires a five-inch minimum straight section, a 3/4-inch ID hose needs seven inches, and a two-inch ID hose must have at least 11 inches of hose length between the couplings.
A less costly alternative is to install Gates MegaSys® constant-pressure hydraulic hoses that have the smallest bend radius of any SAE-equivalent hose in the industry.

The Gates spiral-wire and wire-braid hoses can be bent up to one-third the SAE specification, thereby saving overall hose assembly length and cost by as much as 64 percent.

This flexibility also means that Gates MegaSys hoses are easier to handle, and can be routed in tighter spaces during installation, thus reducing downtime.

Proper Crimping
Assembly problems can be avoided by following the crimp and assembly recommendations of the manufacturer of the products being used. One common cause of failure is incorrect crimping, which results when a hose is cut incorrectly, or when the hose is not properly inserted onto the stem of a coupling.

Be aware of worn die fingers when using older model crimpers. Die wear is a real concern, especially on dead stop crimpers. When die fingers get worn, the crimp can become loose, and eventually, a hose assembly blowout is inevitable.

Hose Cleanliness
Contaminants, the natural enemy of hydraulic systems, cause more than 70 percent of all failures. If not controlled, particles too small to be seen can reduce hydraulic system efficiency by as much as 20 percent.

Contamination affects hydraulic systems in many ways.

• Corrosion of hydraulic systems from acids that form due to fluid breakdown and mixing of incompatible fluids in the system.

• Increased internal leakage that lowers the efficiency of pumps, motors, and cylinders. It decreases the ability of valves to control flow and pressure accurately. It also wastes horsepower and generates excess heat.

• Sticking of parts due to sludge or silting. Silting is a collection of fine particles in critical areas, which will impair proper system operation.

• Seizure of parts or components caused by large amounts of contaminants getting stuck in the clearances.
There are several major sources for system contamination. They are:

1. Contamination built-in at the point of manufacture
2. Hydraulic fluid contamination
3. Environmental contamination
4. System wear contamination
5. Contamination introduced during the servicing process

Preventive measures include blowing air through the hose, flushing the hose with a solvent and using a cleaning kit with a sponge projectile after the couplings are attached.

The true value of a hydraulic hose and coupling assembly comes from using an integrated systems approach: all elements of the hose assembly process are designed together to produce factory-quality assemblies that perform above and beyond industry standards.

Additional Resources
To learn more about hydraulic hose and coupling systems, visit www.gates.com/hydraulics. For specific application questions, contact a Gates Fluid Power Product Application engineer at 303-744-5070 or email pa0000@gates.com.
SAE Hose Constructions

Here’s an overview of SAE J517 specifications. Unless otherwise noted, each hose has an oil-resistant, synthetic-rubber inner tube compatible with petroleum and water-based hydraulic fluids, an oil and weather-resistant synthetic rubber cover, and an operating temperature range from –40 to 100°C.

SAE 100R1: Type A hose has one braid of high-tensile-strength wire around an oil resistant tube (commonly nitrile), and an oil, weather, UV, and ozone-resistant cover commonly made of NBR or NBR/PVC blend. Type AT has the same construction as Type A, except the cover does not need to be removed to assemble with fittings. Type S has the same construction as Type AT and working pressures of ISO 436-1, Type 1SN.

SAE 100R2: hose has two braids of steel-wire reinforcement. A ply or braid of suitable material may be used over the inner tube and/or wire reinforcement to anchor the rubber to the wire. Type A requires skiving (removing) a portion of the cover to assemble with fittings. Type AT has the same construction as Type A, except the cover does not need to be removed to assemble with fittings. Type S has the same construction as Type AT and working pressures of ISO 1436-1, Type 2SN.

SAE 100R3: hose has two braids of textile yarn. It is generally used in low-pressure applications with petroleum oils, antifreeze, or water.

SAE 100R4: hose has one or more plies of woven or braided textile fibers with a spiral of body wire. It’s typically used for return and suction lines.

SAE 100R5: hose is reinforced with two textile braids separated by a high-tensile-strength steel-wire braid. All of the braids are impregnated with an oil and mildew-resistant synthetic rubber compound.

SAE 100R6: hose includes one braided or spiral ply of textile yarn. It’s for general-purpose, low-pressure applications.

SAE 100R7: thermoplastic hose should be used with synthetic, petroleum, and water-based hydraulic fluids at temperatures from –40 to 93°C. It consists of a thermoplastic inner tube resistant to hydraulic fluids with synthetic-fiber reinforcement and a hydraulic fluid and weather-resistant thermoplastic cover. Nonconductive 100R7 is identified with an orange cover and appropriate layline. Pressure capacity is similar to that of 100R1.

SAE 100R8: high-pressure thermoplastic hose should be used with synthetic, petroleum, and water-based hydraulic fluids within a temperature range from –40 to 93°C. It has a thermoplastic inner tube resistant to hydraulic fluids, synthetic-fiber reinforcement, and a hydraulic fluid and weather-resistant thermoplastic cover. Nonconductive 100R8 is identified with an orange cover and appropriate layline. Pressure capacity is similar to that of 100R1.

SAE 100R9, SAE 100R10, and SAE 100R11 hoses types have been removed from the SAE standard.

SAE 100R12: hose should be used with petroleum and water-based hydraulic fluids within a temperature range from –40 to 121°C. It has four spiral plies of heavy wire wrapped in alternating directions. A ply or braid of suitable material may be used over the inner tube and/or over the wire reinforcement to anchor the synthetic rubber to the wire.

SAE 100R13: hose is for petroleum and water-based hydraulic fluids within a temperature range from –40 to 121°C. Multiple spiral plies of heavy wire wrapped in alternating directions cover the inner tube. It’s for high-pressure applications subject to surges or flexing.

SAE 100R14: hose handles petroleum, synthetic, and water-based hydraulic fluids within a temperature range from –54 to 204°C. Type A consists of an inner tube of polytetrafluoroethylene (PTFE) reinforced with a single braid of stainless steel. Type B has the same construction as Type A, but with the additional feature of an electrically conductive inner surface to prevent buildup of electrostatic charge.

SAE 100R15: hose should only be used with petroleum-based hydraulic fluids within a temperature range from –40 to 121°C. It has multiple spiral plies of heavy wire wrapped in alternating directions. A ply or braid of suitable material may be used over or within the inner tube and/or over the wire reinforcement to anchor the rubber to the wire.

SAE 100R16: hose has one or two braids of steel-wire reinforcement. It’s for high-pressure hydraulic applications requiring tight bends and high flexibility.

SAE 100R17: hose, with one or two braids of steel-wire reinforcement, has a constant working pressure rating of 3,000 psi.

SAE 100R18: thermoplastic hose should be used for synthetic, petroleum, and water-based hydraulic fluids in a temperature range from –40 to 93°C. It has a thermoplastic inner tube that resists hydraulic fluids, synthetic-fiber reinforcement, and a hydraulic fluid and weather-resistant thermoplastic cover. Nonconductive 100R18 is identified with an orange cover and appropriate layline. Working pressure rating is 3,000 psi for all sizes.

SAE 100R19: hose has a constant working pressure rating of 4000 psi in all sizes. It has one or two braids of steel-wire reinforcement. A ply or braid of suitable material may be used over the inner tube and/or wire reinforcement to anchor the rubber to the wire.
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Neoprene</th>
<th>Nitrile</th>
<th>Butyl</th>
<th>Hypalon</th>
<th>EPDM</th>
<th>CPE</th>
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<tbody>
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<td>Chemical Name</td>
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<tr>
<td>Designation</td>
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<td>ASTM-SE</td>
<td>SC</td>
<td>SB</td>
<td>R</td>
<td>TB</td>
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<td>SAE J14</td>
<td>BC</td>
<td>BG</td>
<td>AA</td>
<td>CE</td>
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<tr>
<td>SAE J200</td>
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<tr>
<td>Flame</td>
<td>Very Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
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<tr>
<td>Resistance</td>
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<td>Petroleum</td>
<td>Good</td>
<td>Excellent</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Very Good</td>
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<tr>
<td>Base Oils</td>
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<tr>
<td>Diesel Fuel</td>
<td>Good to Excellent</td>
<td>Excellent</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Very Good</td>
</tr>
<tr>
<td>Gas Permeation</td>
<td>Good</td>
<td>Good</td>
<td>Outstanding</td>
<td>Good to Excellent</td>
<td>Fair to Good</td>
<td>Good</td>
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<tr>
<td>Resistance</td>
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<tr>
<td>Weather</td>
<td>Good to Excellent</td>
<td>Poor</td>
<td>Excellent</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Good</td>
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<tr>
<td>Ozone</td>
<td>Good to Excellent</td>
<td>Poor for Tube, Good for Cover</td>
<td>Excellent</td>
<td>Very Good</td>
<td>Outstanding</td>
<td>Good</td>
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<td>Heat</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Excellent</td>
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<tr>
<td>Low Temperature</td>
<td>Fair to Good</td>
<td>Poor to Fair</td>
<td>Very Good</td>
<td>Poor</td>
<td>Good to Excellent</td>
<td>Good</td>
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<tr>
<td>Water-Oil</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Excellent</td>
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<tr>
<td>Emulsions</td>
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<tr>
<td>Water-Glycol</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
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<tr>
<td>Emulsions</td>
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<tr>
<td>Diesters</td>
<td>Poor</td>
<td>Poor</td>
<td>Excellent</td>
<td>Fair</td>
<td>Excellent</td>
<td>Very Good</td>
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<tr>
<td>Phosphate Esters</td>
<td>Fair for Cover</td>
<td>Poor</td>
<td>Good</td>
<td>Fair</td>
<td>Very Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Phosphate Ester Base Emulsions</td>
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<td>Poor</td>
<td>Good</td>
<td>Fair</td>
<td>Very Good</td>
<td>Very Good</td>
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Table 1
Characteristics of Hose Stock Types