# General Hose Information





# General Hose Information

## Hose Construction

### Hose Construction

A hose consists of three components including the tube, reinforcement, and cover. Each component serves an important function in contributing to the overall performance of the hose.

**Components of a hose:**

**Tube** functions:

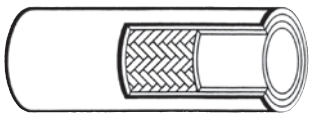
- Conveys media
- Temperature resistant
- Protects reinforcement and cover
- Dissipates static electricity

**Reinforcement** functions:

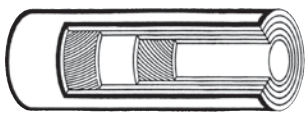
- Supports pressure/ vacuum
- Supports tube
- Controls elongation/ shrinking of hose OD/ID
- Helps fitting retention

**Reinforcement** types:

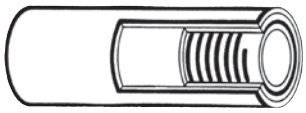
1) Braid - carbon steel or fiber
2) Spiral - carbon steel or fiber
3) Helical - carbon steel



Braid reinforcement



Spiral reinforcement



Helical reinforcement

**Cover** functions:

- Protects reinforcement from external environment
- Provides weather, abrasion, chemical, temperature, and ozone resistance

### Hose Selection

Selecting the proper hose for an application is critical to ensure safety of people and property, as well as long hose life. Therefore, it is important to understand the factors involved.

**Factors include:**

- Application
- Pressure and/or suction
- Environment
- Compatibility with material conveyed
- Temperature
- Size
- Flexibility
- Bend radius
- Weight

### Application

The first step in properly selecting a hose is to identify the application and material to be transferred. Then consider the hoses available for that type of service. Eaton Industrial hose is intended for specific applications and materials.

**WARNING Hose use and care: Never use a hose to transfer material it is not specifically meant to transfer. Doing so could deteriorate the hose and result in leaking, hose bursting, or end blow-offs. This could lead to serious personal injury or death. Always transfer material in a hose that is designed specifically to transfer that material.**

A special application consideration, especially in gases, petroleum-based liquids, volatile solvents, and dry material transfer applications, is whether the velocity of the material being transferred will cause static buildup. This, in turn, can cause an explosion.

**According to ARPM Hose Handbook 8th edition 2009:**

Electrical engineers differ in opinion on the effects of static electricity and the means of dissipating it. In handling gasoline and other petroleum-based liquids, recognized national associations and companies have conflicting opinions on the need for conductive hoses.

Until a consensus is reached among all associations, laboratories and users and a standard practice is established, it is essential that the user determine the need for a static bonded hose based on (a) the intended use of the hose, (b) instructions from the company's Safety Division, (c) the ensurer, and (d) the laws of the states in which the hose will be used.

Some types of hose include a body reinforcing wire. This wire can be used for electrical continuity provided that proper contact is made between it and the hose coupling. This can be done by extending the body wire to the ends of the hose, or by attaching a light static wire to the outermost coils of the body wire. This lighter wire is led through the ends of the hose and attached to the couplings. In nonwire reinforced hose, a static wire can be included in the hose body.

The tendency has been toward a grounding connection completely separate from the hose or to have the tube or cover of the hose conducting. Examples would be sand blast hose with conducting tube or aircraft fueling hose with a conducting cover.

An internal static wire could break or lose contact with the couplings and not be detected visually. This could occur from an unusual stress imposed on the hose.

Finally, be aware that many industries have governing agencies that issue mandatory or suggested guidelines for the use of hose in certain applications.

# General Hose Information

## Hose Construction

### Pressure & Suction

The selected hose and coupling must be able to continually withstand the maximum pressure that will be generated in the application.

**WARNING Hose use and care: Consider both working pressure and pressure surges when determining "maximum" pressure. Failure to select a hose that meets both these requirements could lead to end blow-offs, hose leakage, and hose bursting. The result could be serious injury or death. The Eaton Industrial hose you choose must meet or exceed the required working pressure, and must have a safety factor to allow for surge pressure.**

It may be reassuring to know that every length of Eaton Industrial chemical transfer hose is pressure tested to 1-1/2 times the working pressure before it is packaged and shipped.

**CAUTION In suction applications, suction (or vacuum) considerations are as critical to hose life as pressure considerations. Hoses in these applications are vulnerable to crushing forces because the atmospheric pressure outside the hose is greater than the pressure inside the hose. A hose not having the proper suction rating for your applications may collapse and result in equipment failure.**

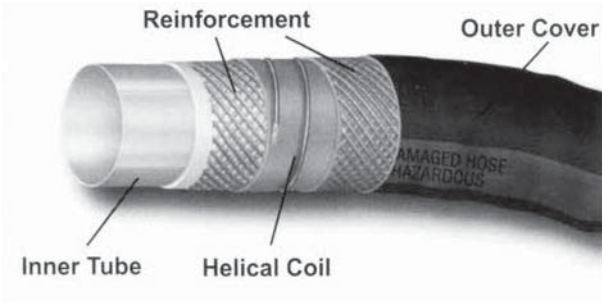
Eaton Industrial suction hoses have helical wire reinforcement and are rated for full vacuum. "Inches of mercury" is the standard of measurement for vacuum. Full vacuum is equal to 29.92 inches of mercury.

### Environment & Compatibility

Environment refers to both the external environment and the internal environment in which the hose will be working. Different components of the hose will be affected by these two types of environment.

Most hoses consist of three components: an inner tube, a reinforcement, and an outer cover.

Elastomers are the basic ingredient of all rubber compounds. However, be aware that when specifying tube and cover compounds, significant application differences may exist between two compounds listed as having the same basic elastomer.




For example, Eaton Industrial's Tiger and Otter hoses list inner tubes made from EPDM, but *recommended* use for each of these hoses is quite different.

These differences occur because compounds contain many materials in addition to elastomers. Some of these materials include processing aids, carbon black, vulcanization agents, accelerators, age resistors, and other ingredients. Before making assumptions about the suitability of a particular hose for a given application, always read the "Applications" information for each specific hose listed in this catalog.

The first hose component, the inner tube, conveys the material being transferred. The tube must be compatible with these materials. This is the hose's internal environment. Whenever you specify a Eaton Industrial hose, refer to the chemical resistance chart in this catalog.

**DANGER Never transfer material in an inner tube that is not compatible with that material. Likewise, never use hose at temperatures, pressures, or chemical concentrations above those recommended by Eaton. Doing so will weaken or deteriorate the hose, leading to leakage, hose bursting, or end blow-offs. Personal injury or death can result.**

The next hose component, the reinforcement, is the strength member of the hose. Reinforcement usually consists of fiber, thermoplastic, carbon steel, or stainless steel spirals, braids and coils. The helical coil is used in all hardwall hoses and is required in vacuum and suction applications. The coil is necessary to help the hose withstand atmospheric pressure that is greater than the internal pressure of the hose to prevent the hose from collapsing. It is usually made of steel or thermoplastic monofilament.

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## Hose Construction

The final hose component is the outer cover. The outer cover protects the reinforcement from the external environment. It is usually rubber, thermoplastic, fiber, or metal. The hose outer cover must protect against weathering, abrasion, chemicals, extreme temperature ranges, ozone, and other adverse conditions.

The "Elastomers" chart in this catalog (page M-14) contains a listing of general characteristics of some common elastomers and their physical properties as they relate to specific service needs. When application questions arise, contact Eaton Technical Support:

- For North America, contact Eaton Technical Support at 1-888-258-0222 available 7:30 AM CST–4:30 PM CST
- For global support, contact your local Eaton technical representative.

Heat can be a catalyst for chemical reaction. When selecting a Eaton Industrial hose, consider both the ambient temperature and the temperature of the material being conveyed.

**WARNING Do not use a hose at temperatures that exceed the hose temperature rating. Doing so could deteriorate the hose, leading to leaks, hose bursting, and end blow-offs. This could result in serious personal injury or death.**

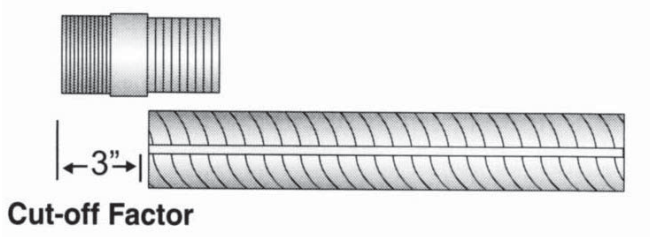
Cold temperatures are another consideration. Hose must be flexible and be able to withstand temperatures well below 0°F in some applications.

Be aware that rated hose temperatures do not imply that a hose can handle all materials within the listed temperature range and concentration.

For specific application information and hose temperature ratings, always follow the guidelines in this catalog, or contact Eaton Technical Support:

- For North America, contact Eaton Technical Support at 1-888-258-0222 available 7:30 AM CST–4:30 PM CST
- For global support contact your local Eaton technical representative.

All chemicals listed in the chart are rated at 70°F unless otherwise stated.



Cut-off Factor

### Size

Size can refer to the length of the hose, the inner diameter (I.D.), and the outer diameter (O.D.). To determine the correct length of hose for an application, always remember to subtract the cut-off factor for each end fitting or coupling from the overall length of the assembly. For example, if the total length of the assembly needs to be 20 feet, and each end extends past the hose three inches, the cut-off factor is three inches at each end, or six inches total. Twenty feet minus six inches yields a hose length of 19-1/2 feet.

Remember to subtract the cut-off factor for each end fitting when preparing hose.

Inner diameter is important in relation to volume transfer requirements. The larger the hose inner diameter, the greater the volume of material that can be transferred in a given time.

**WARNING Be aware that if you replace a hose with one having a different I.D. than the original hose, material velocity could increase or decrease, possibly creating static electricity. This could lead to an explosion causing serious injury or death.**

# General Hose Information

## Hose Maintenance

### Hose Maintenance

Hose has a limited life based on the severity and type of chemical contact, environment or exposure to heat and petroleum products. Eaton recommends the following maintenance procedure to determine when hose should be replaced.

### General Test and Inspection Procedures for Hose

An inspection and hydrostatic test should be done periodically to ensure hose is suitable for continued service.

A visual inspection of the hose should be made for loose covers, kinks, bulges, or soft spots which might indicate broken or displaced reinforcement. The couplings or fittings should be closely examined and, if there is any sign of movement of the hose from the couplings, the hose should be removed from service.

The periodic inspection should include a hydrostatic test for one minute at 150 percent of the recommended working pressure of the hose. During the hydrostatic test, the hose should be straight, not coiled or in a kinked position. Water is the usual test medium and, following the test, the hose may be flushed with alcohol to remove traces of moisture. A regular schedule for testing should be followed and inspection records maintained.

### Hose Inspection

Hose assemblies shall be inspected and tested immediately after the hose is subjected to abnormal abuse such as: severe end pull, flattening or crushing or sharp kinking. As you inspect a hose assembly, remember that most hose failures occur between the coupling and the first three feet along the hose length. Pay close attention to this area. Any hose that has been recoupled shall be proof-tested for one minute at 150 percent of the recommended working pressure of the hose, and inspected before being placed in service.

**SAFETY WARNING: Before conducting any pressure tests on hose, provision must be made to ensure the safety of the personnel performing the tests and to prevent any possible damage to property. Only trained personnel using proper tools and procedures should conduct any pressure tests.**

**The following guidelines should be adhered to during testing and/or inspection:**

1. **Air or any other compressible gas must never be used as the test medium because of the explosive action of the hose should a failure occur. Such a failure might result in possible damage to property and serious bodily injury.**
2. **Air should be removed from the hose by bleeding it through an outlet valve while the hose is being filled with the test medium.**
3. **Hose to be pressure tested must be restrained by placing steel rods or straps close to each end and at approximate 10 foot (3m) intervals along its length to keep the hose from "whipping" if failure occurs; the steel rods or straps are to be anchored firmly to the test structure but in such a manner that they do not contact the hose which must be free to move.**
4. **The outlet end of hose is to be bulwarked so that a blown-out fitting will be stopped.**
5. **Provisions must be made to protect testing personnel from the forces of the pressure medium if a failure occurs.**
6. **Testing personnel must never stand in front of or in back of the ends of a hose being pressure tested.**
7. **If liquids such as gasoline, oil, solvent, or other hazardous fluids are used as the test fluid, precautions must be taken to protect against fire or other damage should a hose fail and the test liquid be sprayed over the surrounding area.**

### Visual Inspection

**1. Hose**

Any cuts, gouges or tears in the cover which do not expose the reinforcement should be repaired before the hose is returned to service. If the reinforcement is exposed, retire the hose from service.

Covers may show surface cracking or crazing due to prolonged exposure to sunlight, ozone, or high temperature during soak tank cleaning. Such deterioration, which does not expose reinforcing materials, is not cause for retirement.

Check for signs of soft spots, blisters, and kinking. If soft spots exist, pressure test the hose assembly and determine whether it is necessary to discard it.

**WARNING If cover blisters exist, be careful not to pop them. If the hose was damaged in such a way that material was allowed to leak between the cover and inner tube, the blisters may contain this material. If the material is hazardous and splatters when the blisters are popped, it could cause serious physical injury.**

# General Hose Information

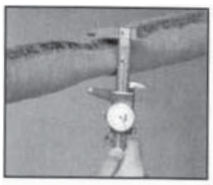
## Hose Maintenance

Look for any indication of kinking or broken reinforcement as evidenced by any permanent distortion, longitudinal ridges, or bulges.

According to RMA IP-11-7 Chemical Hose Bulletin, crushed or kinked spots where the hose O.D. is reduced by 20 percent or more of the normal O.D. indicate the hose probably has internal damage. The hose assembly must be removed from service to ensure the safety of people in the work area.

**⚠ WARNING: Kinks can cause hose to burst, leading to bodily harm.**

Hose containing kinked or crushed spots where the hose O.D. is reduced by 20 percent may be used if the hose passes the hydrostatic tests. Use a caliper to measure the hose outer diameter at several places around the diameter to determine any O.D. reduction. An inspection mirror and a flashlight can be used to inspect the inner tube for abuse, wear, and/or chemical attack.



**2. Couplings**

All metals are subject to attack by various chemicals. Check with the manufacturer to make sure that suitable end fittings, appropriate to both the hose and the chemical being handled, are being used.

Exposed surfaces of couplings, flanges and nipples shall be examined for cracks or excessive corrosion. Either condition shall cause the hose assembly to be retired from service. Any evidence of coupling or nipple slippage on the hose is cause for removing the hose assembly from service.

The Rubber Manufacturers Association (RMA) has published a series of technical bulletins which detail maintenance, testing, and inspection recommendations.

Because the life expectancy of the hose is limited, the user must be alert to signs of impending failure, particularly when the conditions of service include high working pressures and/or the conveyance or containment of hazardous materials. The periodic inspection and testing procedures described here provide a schedule of specific measures which constitute a minimum level of user action to detect signs indicating hose deterioration or loss of performance before conditions leading to malfunction or failure are reached.

**⚠ SAFETY WARNING: Failure to properly follow the manufacturer's recommended procedures for the care, maintenance and storage of a particular hose might result in its failure to perform in the manner intended and might result in possible damage to property and serious bodily injury.**

**Hydrostatic Pressure Test**

For large-bore hose being used in dock service, an inspection card which describes the hose, manufacturer, date received, purchase order number, and date of installation should be maintained for each hose. The inspection card should be used to record the test results and condition of the hose.

Eaton recommends that new hose assemblies be hydrostatically tested before being placed in service. Hydrostatic testing should be done at periodic intervals to determine if a hose is suitable for continued service. The hydrostatic test and examination shall be conducted in the following manner.

**Hose to be pressure tested must be restrained by placing steel rods or straps close to each end and at approximate 10 foot (3m) intervals along its length to keep the hose from "whipping" if failure occurs; the steel rods or straps are to be anchored firmly to the test structure but in such a manner that they do not contact the hose which must be free to move.**

1. Hose shall lie in a straight and horizontal position supported on rollers to permit easy movement when under the test pressure.
2. Water should be used as the test liquid. Never pressure test with solvents, corrosive liquids, or with compressed gases.
3. Fill the hose with water with the outlet end raised and the outlet valve open to ensure the complete removal of air. When all the air has been expelled, close the outlet valve and lower the raised end.
4. For new hose, raise the pressure to 2 times the rated working pressure of the hose and hold for 5 minutes. During this hold period, the hose shall be examined for leaks at the couplings, fitting slippage, or for any indication of weakness in the hose structure.
5. For used hose, test with a pressure of 1-1/2 times the rated working pressure of the hose for one minute and examine as above.
6. Completely relieve test pressure from the system prior to releasing hose from test equipment.
7. Thoroughly drain the water from the hose after completion of the hydrostatic test.

**Electrical Continuity**

When required by the user, electrical continuity between the fittings shall be tested using an ohm meter. The hose must be clean and dry for this test.

# General Hose Information

## Hose Maintenance

### General Care and Maintenance of Hose

Hose should not be subjected to any form of abuse in service. It should be handled with reasonable care. Hose should not be dragged over sharp or abrasive surfaces unless specifically designed for such service. Care should be taken to protect hose from severe end loads for which the hose or hose assembly was not designed. Hose should be used at or below its rated working pressure; any changes in pressure should be made gradually so as to not subject the hose to excessive surge pressures. Hose should not be kinked or be run over by equipment. In handling large size hose, dollies should be used whenever possible; slings or handling rigs, properly placed, should be used to support heavy hose used in oil suction and discharge service.

### Hose Repair

There are some circumstances in which chemical hoses can be repaired. For example, if a hose has been kinked near the coupling and a close inspection of the assembly reveals that this is the only damage, the assembly can be repaired.

**WARNING Wear safety glasses, gloves, and protective clothing when cutting hose. They will help protect your eyes and skin from flying debris.** When recoupling a used hose assembly, begin by cutting the hose far enough beyond the shank to eliminate the possibility of cutting into the shank. When cutting out a kink, cut behind the kink far enough so that the ID/OD of the remaining hose is round. Use calipers to confirm roundness. Make sure to cut the hose squarely. Next wipe the inner tube of the cut end with a clean rag.

Before recoupling the hose, make sure to carefully inspect the tube. This is important because it is easy to see the condition of the tube and reinforcement of the hose when the coupling is cut off. Look for any evidence of deterioration of the hose tube. If there are signs of deterioration, remove the hose assembly from service. If after close inspection none of these signs is present, the hose may be recoupled.

Any hose that has been used to convey an abrasive material, such as plastic pellets and powders, should not be recoupled due to the inherent thickness reduction that results from the transfer of abrasive materials.

Finally, pressure test and tag any recoupled assembly as recommended.

### Storage

Proper storage conditions can enhance and extend substantially the ultimate life of hose products. Rubber hose products in storage can be affected adversely by temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids and fumes, insects, rodents and radioactive materials. The appropriate method for storing hose depends to a great extent on its size (diameter and length), the quantity to be stored, and the way in which it is packaged. Hose should not be piled or stacked to such an extent that the weight of the stack creates distortions on the lengths stored at the bottom. Since hose products vary considerably in size, weight, and length, it is not practical to establish definite recommendations on this point. Hose having a very light wall will not support as much load as would a hose having a heavier wall or hose having a wire reinforcement. Hose which is shipped in coils or bales should be stored so that the coils are in a horizontal plane.

**Storage Do's:**

- Whenever feasible, rubber hose products should be stored in their original shipping containers which provide some protection against the deteriorating effects of oils, solvents, and corrosive liquids; shipping containers also afford some protection against ozone and sunlight.
- Certain rodents and insects will damage rubber hose products, and adequate protection from them should be provided. Be sure ends are capped to keep out insects, rodents, and other contaminants that can damage the hose.
- Hose shipped in coils or bales should be stored so the coils are in a horizontal plane.
- Store items on a first-in, first-out basis. Remember that even under the best of conditions, an unusually long shelf life will deteriorate certain rubber products. Inspect and test the hose assembly before placing it in service. Usually, any wear or damage will be apparent during inspection or testing.
- The ideal temperature for the storage of rubber products ranges from 50° to 70°F (10-21°C) with a maximum limit of 100°F (38°C). If stored below 32°F (0°C), some rubber products become stiff and will require warming before being placed in service.
- Storage areas should be relatively cool and dark, and free of dampness and mildew. Items should be stored on a first-in, first-out basis, since even under the best of conditions, an unusually long shelf life could deteriorate certain rubber products.

**Storage Don'ts:**

- Don't pile or stack hose to such an extent that the weight of the stack distorts the lengths stored on the bottom. Remember that hose having a very light wall will not support as much load as a hose having a heavier wall or wire reinforcement.

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## Hose Maintenance

- Don't store rubber products near heat sources such as radiators and base heaters, or near electrical equipment that might generate ozone. Also do not store hose for long periods in geographical areas of known high ozone concentration. Ozone ages rubber.
- Don't expose hose to direct or reflected sunlight during storage. This ages rubber.
- Don't store uncovered hose under fluorescent or mercury lamps. They generate light waves harmful to rubber.
- Don't hang hose assemblies on hooks, nails, or other devices which could cut or damage hose.

The Rubber Manufacturers Association has published separately a series of Hose Technical Information bulletins describing hoses designed for different applications which detail Maintenance, Testing and Inspection recommendations. Refer to the *ARPM Catalog of Publications*, issued annually, to determine the availability of the latest edition. Bulletins published include the following:

**Publication No.**

IP 11—1— Steam Hose

IP 11—2— Anhydrous Ammonia Hose

IP 11—4— Oil Suction and Discharge Hose

IP 11—5— Welding Hose

IP 11—6— Fire Hose

IP 11—7— Chemical Hose

IP 11—8— Fuel Dispensing Hose

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1400 K Street, N.W.
Washington, D.C. 20005

RMA Publications order desk: (800) 325-5095

### Proper Used Hose Storage

Before placing used hose in storage, completely drain it and flush out any potentially explosive vapors or corrosive residues.

Also make sure you dispose of waste in a manner that complies with federal, state, and local environmental regulations.

**⚠ WARNING: Take extreme care when flushing out a chemical hose with water. Some chemicals, such as concentrated acids, may react with water and cause spattering. These materials can cause serious personal injury or death if they get into eyes or onto skin. Wear safety glasses, gloves and other protective clothing to help guard against this.**

Continue by laying the hose assembly on a solid support, allowing air to circulate through it. This helps extend the hose life. Further, store the hose in a cool, dark, dry place at a temperature ideally between 50°F and 70°F.

### Proper Hose Handling

Proper hose handling can help preserve hose assembly life and work environment safety. Therefore, consider the following points when handling hose assemblies.

- Avoid crushing or kinking the hose. This can cause severe damage to the reinforcement that isn't always obvious when looking at the cover.
- Do not drag the hose or lift a large bore hose from the middle of its length with the ends hanging down. Doing so can cause kinking, cover cuts, hose reinforcement damage, and coupling damage.
- Limit the curvature of the hose to the minimum bend radius recommended by the manufacturer. Also avoid sharp bends at the end fittings and at manifold connections.
- Do not exceed pressure and temperature limits because this could damage the hose and ultimately result in serious bodily injury or property damage. Monitor pressure and temperature during hose use.
- Never allow chemicals, solvents, or any other hazardous materials to drip onto ground. Always comply with environmental laws.
- Never allow chemicals to drip on the exterior of a hose or allow hose to lay in a pool of chemicals. The hose cover may not have the chemical resistance of the tube. If a corrosive material comes into contact with the hose reinforcement, the result could be early hose failure.
- Avoid extreme flexing of the hose near the coupling. If necessary, use elbows in the piping system to assure a straight line connection with the hose.
- Protect hose from heat, flame, cutting, and twisting. Use shields or clamps to do this.
- Support hose to avoid mechanical strain on couplings.
- Be aware that dropping or dragging the assembly, chemical incompatibility, exposure to temperature extremes, or extensive internal coupling abrasion can cause leaks and reduce coupling retention.

**⚠ WARNING: Do not use damaged hose. Doing so could result in serious personal injury or death.**

# General Hose Information

## Hose Maintenance

### Cleaning Hose Assemblies

Cleaning of hose assemblies should be done at a facility with the means of disposing of wastes and hazardous materials properly. All water and/or cleaning solutions used should be retained and disposed of in a way that complies with applicable laws.

Eaton Industrial does not recommend that distributors handle hose assemblies that have not been cleaned properly.

When you clean a tank or change the materials to be transferred, clean the hose assemblies. Three methods can be used: the soak tank, the closed loop system, or the rotating brush. The most appropriate method will depend on the hose use and location.

**⚠ WARNING: Use of pressure wands to clean hose is not recommended. The high concentration of heat and pressure in a confined area can damage the hose inner tube and lead to hose bursting, leakage, spraying, or end blow-offs. This could cause serious personal injury or death.**

**⚠ WARNING: Always wear safety glasses, gloves, and protective clothing when cleaning hose, no matter which hose cleaning method you use. Otherwise, burns, blisters, eye damage or other injuries could occur.**

If you choose the soak tank method, the cleaning solution usually caustic soda and water- should be no more than 150°F. Gently lay the hose in the cleaning solution to prevent it from splashing.

Soak the hose no more than 15 minutes to prevent the hose from becoming brittle with a shortened service life. Flush the hose thoroughly with clean water. After making sure that all the water is drained from the hose, store the hose in a cool, dry place. Once the hose has cooled (approximately 45 minutes), cap the ends to keep contaminants out.

The second method of cleaning is the closed-loop system. With this method, the caustic solution used to clean the tank is also pumped through the hose and back to the tank. Typically, fluid is 180°F and is pumped through the system until the tank is clean.

When the cleaning process is complete, flush the hose thoroughly with water. Store the hose in a cool, dry place. Cap the ends to keep contamination out.

**⚠ WARNING: Strong acids should be thoroughly drained prior to and after cleaning to avoid an exothermic reaction.**

### Class Oil Resistance

Rubber hose is used to convey petroleum products both in the crude and refined stages. The aromatic content of refined gasoline is often adjusted to control the octane rating. The presence of aromatic hydrocarbons in this fuel generally has a greater effect on rubber components than do aliphatic hydrocarbons. Aromatic materials in contact with rubber tend to soften it and reduce its physical properties. For long lasting service, the buyer of gasoline hose should inform the hose manufacturer of the aromatic content of the fuel to be handled so that the proper tube compound can be recommended for the specific application.

The effects of oil on rubber depend on a number of factors that include the type of rubber compound, the composition of the oil, the temperature and time of exposure. Rubber compounds can be classified as to their degree of oil resistance based on their physical properties after exposure to a standard test fluid. As a guide to the user of the hose in contact with oil, the oil resistance classes and a corresponding description are listed.

**Physical Properties After Exposure to Oil**

| | Volume Change Maximum | Tensile Strength Retained |
|---|---|---|
| Class A<br>(High oil resistance) | +25% | 80% |
| Class B<br>(Medium-High oil resistance) | +65% | 50% |
| Class C<br>(Medium oil resistance) | +100% | 40% |

# General Hose Information

## Troubleshooting


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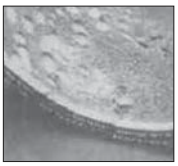
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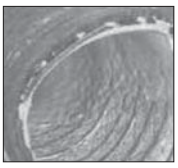
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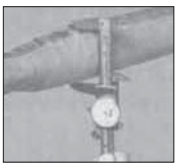
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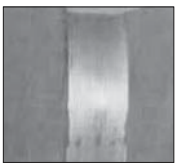

8.


9.

**⚠ WARNING: Selection of the proper hose for the application is essential to the proper operation and safe use of the hose and related equipment. Inadequate attention to selection of hose for the application can result in serious bodily injury or property damage. In order to avoid serious bodily injury or property damage resulting from selection of the wrong hose, you should carefully review the information in this catalog.**

**Hose failures can be caused by conditions such as excessive pressures, fluid incompatibility, extreme temperatures and many more. Eaton has illustrated below some of the more common failures. If the conditions you are experiencing are not listed, please contact Eaton Technical Support for North America at 1-888-258-0222 for global technical support contact your local Eaton technical representative.**

1. **Problem:** The hose has exposed reinforcement and a loose cover. This could be caused by an abrasive environment or the life of the hose has been exceeded.

**Solution:** Route hose properly to avoid excessive abrasion. Some hoses are made with materials that handle abrasion better.

2. **Problem:** Cracks in the hose cover can be caused by prolonged exposure to sunlight, ozone or high temperatures.

**Solution:** Store hose in cool dark areas when possible. Do not store or use the hose where the recommended temperature rating is exceeded.

3. **Problem:** Cuts, gouges, or tears in hose tube can be caused by improper cleaning with high-pressure water wand.

**Solution:** Do not use high pressure water wand to clean hoses. Instead, three cleaning methods are commonly used: the soak tank, the closed loop system or the rotating brush. The most appropriate method will depend on the hose use and location.

4. **Problem:** Bubbling and flaking of the tube material caused by the tube not being compatible with the chemical being conveyed.

**Solution:** Check the chemical resistance guidelines to make sure the hose you are using is compatible with the chemical(s) being transferred. Also, make sure the hose can handle the application temperatures.

5. **Problem:** Deterioration of the hose tube has caused the reinforcement to be exposed. This may be caused by abrasive material being conveyed through a hose not made for this abrasive material or hose life has been exceeded.

**Solution:** Make sure that the hose can handle the material being conveyed. Possibly use a hose with a thicker tube.

6. **Problem:** Hose is kinked due to exceeding the minimum bend radius of the hose. The result is damaged reinforcement.

**Solution:** To avoid this problem, check the minimum bend radius of the hose and route the hose so the minimum bend radius is not exceeded.

7. **Problem:** Improperly banded shank may create a possible leak path.

**Solution:** Make sure the coupling is secured tightly and according to manufacturer's specifications. Bands should be placed inside of the barbs on the coupling shank, toward the coupling side. The band farthest from the hose end should be tightened first. If two bands are present, Eaton suggests rotating the clamp buckles 180° from each other.

8. **Problem:** Overtightened band could cause leaks, spraying and end blow-offs. Band was applied with excessive pressure and cut the cover of the hose causing reinforcement to be exposed.

**Solution:** Do not attach bands at pressures that are too high. Apply the bands to the manufacturer's recommended settings.

9. **Problem:** The steam hose has developed cracks in the cover due to heat in the application.

**Solution:** Steam hose has a limited service life. It should be inspected before every use. Any crack that exposes the reinforcement is a reason for the hose to be removed from service.

# General Hose Information

## Flow Rate, Pressure Drop and Flow Capacity

There are several factors which affect selection of a hose sized such that it will provide the desired rate of flow at the required pressure; these are:

- Hose size
- Hose length
- Hose fittings
- Material conveyed
- Bends
- Static head pressure

### Hose Size

Undersized pressure lines produce excessive pressure drop with attendant energy loss and heating, and undersized suction lines cause cavitation at the pump inlet. Oversized hose assemblies, on the other hand, are excessively costly and generally too heavy.

In selecting hose for hydraulic systems, the following empirical values can be used to achieve minimum pressure drop consistent with reasonable hose size (see Chart 2):

*Velocity of pressure lines 7 to 15 ft./sec. Velocity of short pressure lines to 20 ft./sec. Velocity of suction lines 2 to 5 ft./sec. To use Chart 2, lay a straight-edge across the chart as shown by the dotted line. To minimize pressure drop, always use the next larger size hose shown if the line passes between sizes listed.*

### Hose Length

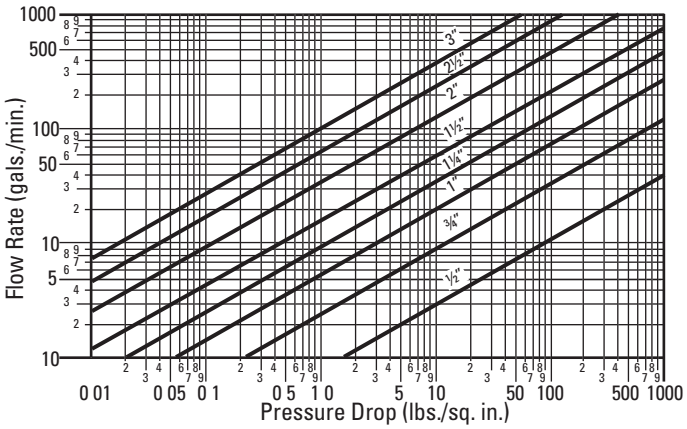
Chart 1 gives the pressure drop in different-sized hoses based on hoses of 100-foot length, and is based on water as the material conveyed. For hoses of a different length, these values must be corrected. For example, a 100-foot length of 1/2" hose causes a pressure drop of 100 lbs./in.$^2$ at a flow rate of 10 gal./min. If the hose in question is 50 feet long, the pressure drop derived from Chart 1 must be corrected by multiplying the value by the ratio of the actual length to 100 feet, or 50/100, or 0.5. Therefore, the actual pressure drop caused by a 50-foot length of 1/2" hose, at a flow rate of 10 gal./min. is 50 lbs./in.$^2$ (0.5 x 100 = 50 lb./in.$^2$).

### Hose Fittings and Fluid Conveyed

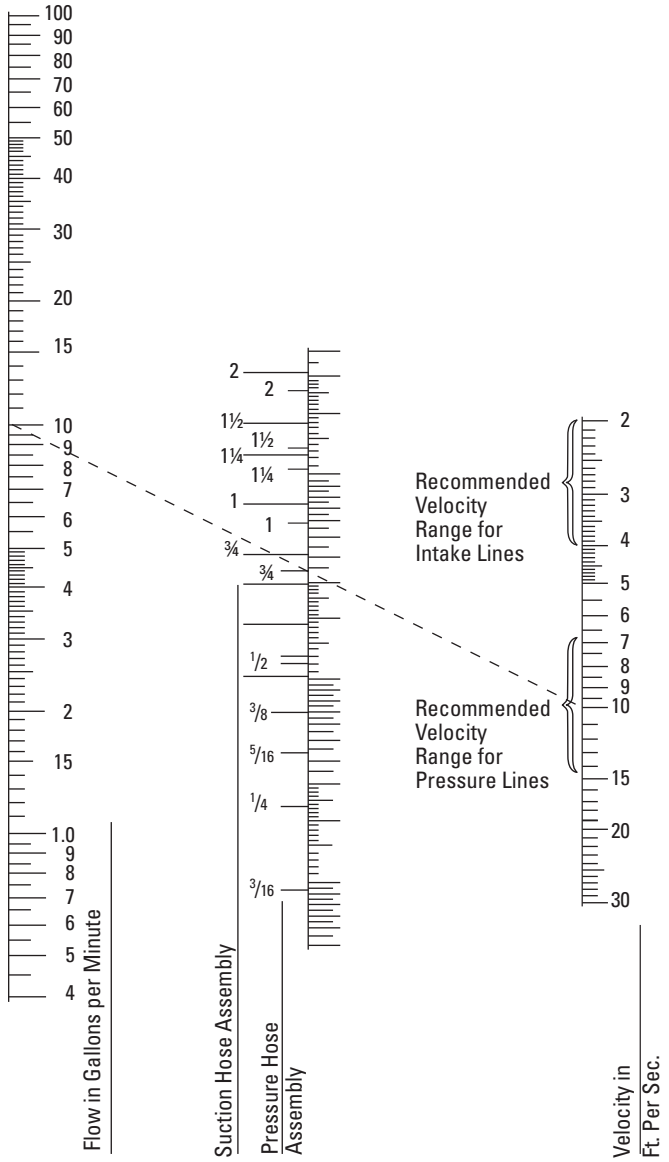
In most cases, the end fitting openings are slightly smaller than the hose itself. However, this varies widely with hose fitting designs from 'full-flow' ends which have the same I.D. as the hose, down to as much as 1/8" smaller I.D. than the hose bore. To allow for this, assume a 10-to-15% greater flow rate than actually measured in the system when determining pressure drop.

Chart 1 is based on water as the material conveyed, and for other fluids it is necessary to correct for the difference in specific gravity and viscosity. Chart 3 lists common fluids, their specific gravities, viscosities, and corresponding correction factors. To determine the pressure drop for a specific fluid, first determine the pressure drop from Chart 1 for the hose length then divide this by the correction factor found in Chart 3. For example, the 50-foot length of 1/2" hose just described had a pressure drop of 50 lbs./in.$^2$ at a flow of 10 gal./min. of water. To determine the pressure drop if #2 fuel oil is the material conveyed, divide by 0.752 (from Chart 3) 50 ÷ 0.752 = 66.5 lbs./in.$^2$ pressure drop. If, on the other hand, the material conveyed is Type #3 gasoline, the pressure drop would be 50 ÷ 1.19 = 42 lbs./in.$^2$

### CHART 1. Hose Flow Rate vs. Pressure Drop




### CHART 2. Hose Flow Capacity



# General Hose Information

## Steam Temperatures

### Temperatures of Saturated Steam at Various Pressures

| Lbs. Per Sq. Inch Pressure | Degrees Fahrenheit | Degrees Centigrade | Lbs. per Sq. Inch Pressure | Degrees Fahrenheit | Degrees Centigrade |
|---|---|---|---|---|---|
| 0 | 212.0 | 100.0 | 110 | 344.1 | 173.4 |
| 5 | 227.1 | 108.4 | 115 | 347.2 | 175.1 |
| 10 | 239.4 | 115.2 | 120 | 350.1 | 176.7 |
| 15 | 249.8 | 121.0 | 125 | 352.9 | 178.3 |
| 20 | 258.8 | 126.0 | 130 | 355.6 | 179.8 |
| 22 | 261.2 | 127.8 | 135 | 358.3 | 181.3 |
| 24 | 265.3 | 129.6 | 140 | 360.9 | 182.7 |
| 26 | 268.3 | 131.3 | 145 | 363.4 | 184.1 |
| 28 | 271.2 | 132.9 | 150 | 365.9 | 185.5 |
| 30 | 274.1 | 134.5 | 155 | 368.2 | 186.8 |
| 32 | 276.8 | 136.0 | 160 | 370.6 | 188.1 |
| 34 | 279.3 | 137.4 | 165 | 373.9 | 189.4 |
| 36 | 281.8 | 138.8 | 170 | 375.3 | 190.7 |
| 38 | 284.4 | 140.2 | 175 | 377.4 | 191.9 |
| 40 | 286.7 | 141.5 | 180 | 379.6 | 193.1 |
| 42 | 289.0 | 142.8 | 185 | 381.7 | 194.3 |
| 44 | 291.2 | 144.0 | 190 | 383.7 | 195.4 |
| 46 | 293.5 | 145.3 | 195 | 385.9 | 196.6 |
| 48 | 295.5 | 146.4 | 200 | 387.9 | 197.7 |
| 50 | 297.7 | 147.6 | 205 | 398.8 | 198.8 |
| 52 | 299.9 | 148.7 | 210 | 391.6 | 199.8 |
| 54 | 301.6 | 149.8 | 215 | 392.9 | 200.5 |
| 56 | 303.6 | 150.9 | 220 | 395.4 | 201.7 |
| 58 | 305.4 | 151.9 | 225 | 397.2 | 202.9 |
| 60 | 307.4 | 153.0 | 230 | 399.0 | 203.9 |
| 62 | 309.2 | 154.0 | 235 | 400.7 | 204.8 |
| 64 | 310.8 | 154.9 | 240 | 402.5 | 205.8 |
| 66 | 312.6 | 155.9 | 245 | 404.2 | 206.8 |
| 68 | 314.2 | 156.8 | 250 | 406.1 | 207.8 |
| 70 | 316.0 | 157.0 | 255 | 407.7 | 208.7 |
| 72 | 317.7 | 158.7 | 260 | 409.4 | 209.7 |
| 74 | 319.3 | 159.6 | 265 | 411.0 | 210.6 |
| 76 | 320.9 | 160.5 | 270 | 412.6 | 211.4 |
| 78 | 322.3 | 161.3 | 275 | 414.2 | 212.3 |
| 80 | 323.8 | 162.1 | 280 | 415.7 | 213.2 |
| 85 | 327.6 | 164.2 | 300 | 421.0 | 216.1 |
| 90 | 331.2 | 166.2 | 350 | 436.5 | 224.7 |
| 95 | 334.6 | 168.1 | | | |
| 100 | 337.8 | 169.9 | | | |
| 105 | 341.1 | 171.7 | | | |

**WARNING** Steam heat is hotter than 212°F (boiling water) and increases in temperature as pressure increases.

# General Hose Information

## Flow Capacities

### Flow Capacities of Hose Assemblies at Suggested Flow Velocities

The chart below is designed and provided as an aid in the determination of the correct hose size.

**Example:** At 13 U.S. gallons per minute, what is proper hose size within the suggested velocity range for pressure lines?

**Solution:** Locate 13 U.S. gallons per minute in the left hand column and 10 feet per second in the right hand column (the center of the suggested velocity range for pressure lines). Lay a straightedge across the two points. The inside diameter is shown in the center column nearest the straight edge.

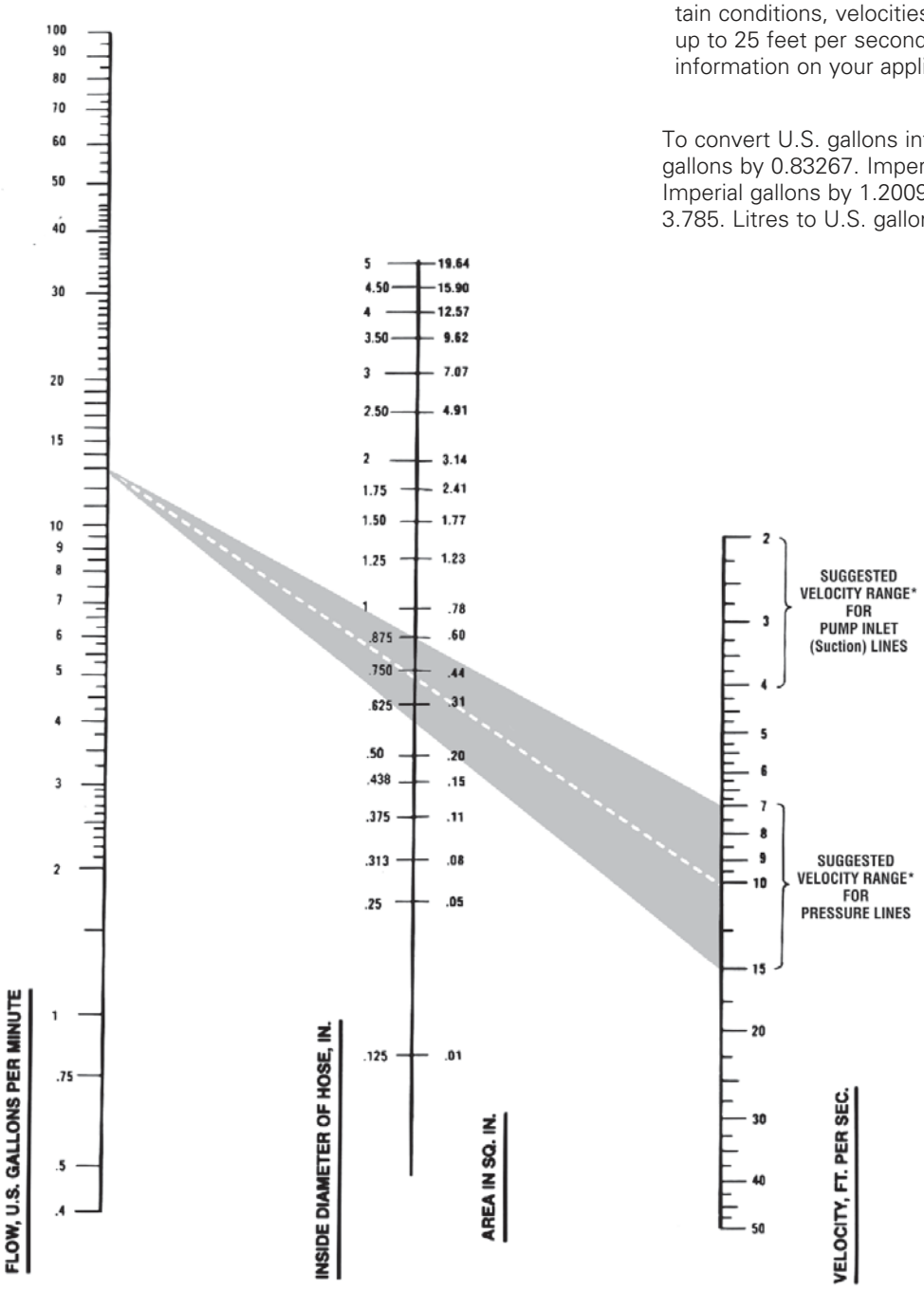
For suction hose, follow the same procedure except use suggested velocity range for pump inlet lines in the right hand column.

Based on Formula

$$\text{AREA (SQ. IN.)} = \frac{\text{G.P.M. x 0.3208}}{\text{VELOCITY (FT./SEC.)}}$$

*Suggestions are for oils having a maximum viscosity of 315 S.S.U. at +100°F (+38°C) and operating at temperatures between +65°F and +155°F (+54°C to +69°C). Under certain conditions, velocities in pressure lines can be increased up to 25 feet per second. Contact Aeroquip with specific information on your application.

To convert U.S. gallons into Imperial gallons multiply U.S. gallons by 0.83267. Imperial gallons into U.S. gallons multiply Imperial gallons by 1.20095. U.S. gallons to litres multiply by 3.785. Litres to U.S. gallons, multiply by 0.2642.



# General Hose Information

## Elastomer Chart

The chart below shows the general characteristics of some of the common rubber compounds. Elastomers are mixed with various chemicals to provide a wide range of physical properties for specific service needs.

| ASTM Designation | Common Name | Composition | General Properties |
|---|---|---|---|
| **CR** | Neoprene | Chloroprene | • Good abrasion<br>• Good weathering resistance<br>• Good oil resistance<br>• Flame retarding |
| **NBR** | Nitrile (Buna-N) | Acrylonitrile-butadiene | • Excellent oil resistance<br>• Moderate resistance to aromatics |
| **IIR** | Butyl | Isobutylene-isoprene | • Excellent ozone resistance<br>• Good resistance to fire resistant fluids<br>• Good heat resistance<br>• Low permeability<br>• Poor resistance to petroleum fluids |
| **CIIR** | Chlorinated Butyl | Chloro-isobutylene isoprene | • Same as Butyl |
| **SBR** | SBR | Styrene-butadiene | • Good abrasion resistance<br>• Poor resistance to petroleum fluids |
| **EPM** | Ethylene Propylene | Rubber Composition | • Excellent ozone resistance<br>• Excellent chemical resistance<br>• Good heat resistance<br>• Poor resistance to petroleum based fluids |
| **EPDM** | EPDM | Ethylene-propylene diene terpolymer | • Excellent ozone resistance<br>• Good chemical resistance<br>• Good temperature resistance<br>• Poor resistance to petroleum fluids |
| **XLPE** | Cross-Linked Polyethylene | Polyethylene & cross linking agents | • Excellent chemical resistance |
| **EVA** | EVA | Ethylvinylacetate | • Excellent flexibility<br>• Chemical resistance |
| **LLDPE** | Linear, low density Polyethylene | Linear, low density Polyethylene | • Excellent ESCR resistant<br>• FDA Approved NSF 51 material available |
| **Nylon 11** | Nylon 11 | Nylon 11 | • Good chemical resistance |
| **PVC/PU Blend** | PVC/PU Blend | Polyvinyl flouride/polyurethane Blend | • Excellent chemical resistance |
| **PVDF** | KYNAR® | Polyvinylidene flouride | • Excellent chemical resistance |
| **PA** | Nylon | Polyamide | • Good abrasion resistance<br>• Good chemical resistance<br>• Low coefficient of friction |
| **CSM** | Hypalon | Chloro-sulfonated Polyethylene | • Excellent ozone resistance<br>• Good abrasion resistance<br>• Good heat resistance<br>• Fair petroleum qualities |
| **NR** | Natural Rubber | Polyisoprene | • Excellent abrasion resistance<br>• Acid resistance<br>• Not oil resistant |
| **V-NBR** | Vinyl Nitrile | PVC/NBR | • Good ozone resistance<br>• Good resistance to animal fats & oils<br>• Good petroleum resistance |
| **UHMWPE** | Ultra-high molecular weight polyethylene | Polyethylene | • Excellent chemical resistance<br>• Moderate heat resistance<br>• Excellent abrasion resistance<br>• FDA-accepted material |
| **CM** | CPE | Chlorinated Polyethylene | • Excellent ozone resistance<br>• Excellent weathering resistance<br>• Good abrasion resistance<br>• Good heat resistance<br>• Good resistance to petroleum oils |
| **XNBR** | Carboxylated Nitrile | Carboxylated Acrylonitrile-butadiene | • Excellent abrasion resistance<br>• Excellent oil resistance<br>• Excellent weather resistance |
| **PTFE** | Teflon | Polytetrafluoroethylene | • Excellent temperature resistance<br>• Excellent chemical resistance<br>• FDA accepted material<br>• Low coefficient of friction for high flow rates and easy cleaning<br>• Excellent resistance to thermocycling |
| **PVC** | PVC | Polyvinylchloride | • Resistant to many chemicals<br>• Good flexibility |
| **FEP** | Teflon | Fluorinated Ethylene Propylene | • Excellent temperature resistance<br>• Excellent chemical resistance<br>• FDA accepted material<br>• Low coefficient of friction for high flow rates and easy cleaning<br>• Excellent resistance to thermocycling |

# General Hose Information

## Flow Capacities Pressure Drop

Pressure drop in psi (pounds per square inch)/gpm (gallons per minute) for 10 feet of hose (smooth bore) without fittings.

**Fluid specification:**
Specific gravity = .85; Viscosity = v = 20 centistokes (C.S.), (20 C.S. = 97 S.S.U.).

### Hose Pressure Drop

| Hose Dash Size → | -04 | | -05 | | -06 | | -08 | | -10 | | -12 | | -16 | | -20 | | -24 | | -32 | | -40 | -48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hose I.D. (inches) ← | .19 | .25 | .25 | .31 | .31 | .38 | .41 | .50 | .50 | .63 | .63 | .75 | .88 | 1.00 | 1.13 | 1.25 | 1.38 | 1.50 | 1.81 | 2.00 | 2.38 | 3.00 |
| U.S. Gallons per minute .25 | 10 | 3.1 | 3.1 | | | | | | | | | | | | | | | | | | | |
| .50 | 19 | 6 | 6 | 2.7 | 2.7 | | | | | | | | | | | | | | | | | |
| 1 | 40 | 12 | 12 | 5.5 | 5.5 | 2.4 | | | | | | | | | | | | | | | | |
| 2 | 95 | 24 | 24 | 10 | 10 | 4.8 | 3.5 | | | | | | | | | | | | | | | |
| 3 | 185 | 46 | 46 | 17 | 17 | 7 | 5 | 2.2 | 2.2 | | | | | | | | | | | | | |
| 4 | | 78 | 78 | 29 | 29 | 12 | 8 | 3 | 3 | 1.2 | 1.2 | | | | | | | | | | | |
| 5 | | 120 | 120 | 44 | 44 | 18 | 12 | 4.5 | 4.5 | 1.6 | 1.6 | .72 | | | | | | | | | | |
| 8 | | | | 95 | 95 | 39 | 26 | 10 | 10 | 3.6 | 3.6 | 1.4 | .60 | | | | | | | | | |
| 10 | | | | | | 59 | 40 | 15 | 15 | 5.7 | 5.7 | 2 | 1 | .55 | | | | | | | | |
| 12 | | | | | | 80 | 52 | 20 | 20 | 7.2 | 7.2 | 2.6 | 1.5 | .75 | .43 | | | | | | | |
| 15 | | | | | | | 75 | 30 | 30 | 10 | 10 | 4.2 | 2.2 | 1.2 | .67 | .38 | | | | | | |
| 18 | | | | | | | 107 | 40 | 40 | 15 | 15 | 6.3 | 3 | 1.5 | .70 | .55 | .35 | | | | | |
| 20 | | | | | | | | 49 | 49 | 19 | 19 | 8 | 3.4 | 2 | 1.1 | .65 | .43 | .27 | | | | |
| 25 | | | | | | | | 72 | 72 | 26 | 26 | 11 | 5.5 | 3 | 1.6 | 1 | .64 | .40 | .17 | | | |
| 30 | | | | | | | | | | 34 | 34 | 14 | 7 | 3.6 | 2.2 | 1.3 | .80 | .52 | .22 | .14 | | |
| 35 | | | | | | | | | | 47 | 47 | 19 | 9.5 | 5 | 2.8 | 1.7 | 1.1 | .70 | .27 | .18 | | |
| 40 | | | | | | | | | | | | 25 | 12 | 6.5 | 3.4 | 2.2 | 1.4 | .90 | .38 | .24 | | |
| 50 | | | | | | | | | | | | 36 | 17 | 9 | 5.3 | 3.3 | 2 | 1.3 | .54 | .35 | .15 | |
| 60 | | | | | | | | | | | | 50 | 23 | 12 | 7.5 | 4.4 | 2.8 | 1.8 | .75 | .45 | .20 | |
| 70 | | | | | | | | | | | | | 31 | 17 | 9.3 | 6 | 3.8 | 2.4 | 1 | .65 | .30 | |
| 80 | | | | | | | | | | | | | 38 | 21 | 12 | 7.1 | 4.6 | 3 | 1.2 | .76 | .34 | .11 |
| 90 | | | | | | | | | | | | | 49 | 27 | 15 | 9 | 5.9 | 3.8 | 1.5 | 1 | .45 | .13 |
| 100 | | | | | | | | | | | | | | 33 | 19 | 12 | 7 | 4.7 | 1.9 | 1.3 | .55 | .18 |
| 150 | | | | | | | | | | | | | | 60 | 36 | 22 | 13 | 8.5 | 3.4 | 2.2 | 1 | .33 |
| 200 | | | | | | | | | | | | | | | | 36 | 23 | 15 | 6 | 3.9 | 1.7 | .55 |
| 250 | | | | | | | | | | | | | | | | 54 | 33 | 22 | 8.5 | 5.3 | 2.5 | .75 |
| 300 | | | | | | | | | | | | | | | | | 45 | 29 | 12 | 7.5 | 4 | 1.1 |
| 400 | | | | | | | | | | | | | | | | | | 51 | 21 | 14 | 6.5 | 2.2 |
| 500 | | | | | | | | | | | | | | | | | | | 32 | 20 | 10 | 3 |
| 800 | | | | | | | | | | | | | | | | | | | | | 18 | 5 |
| 1000 | | | | | | | | | | | | | | | | | | | | | | 10 |

*Pressure drop values listed are typical of many petroleum based hydraulic oils at approximately +100°F (+38°C).
Differences in fluids, fluid temperature and viscosity can increase or decrease actual pressure drop compared to the values listed.

**To Convert**

U.S. gallons into Imperial gallons multiply U.S. gallons by 0.83267. Imperial gallons into U.S. gallons multiply Imperial gallons by 1.20095. U.S. gallons to litres multiply by 3.785. Litres to U.S. gallons, multiply by 0.2642.

# Hose Index

# Eaton Terms and Conditions

## Standard Terms and Conditions of Sale



These terms and conditions of sale are between the Buyer and the Eaton affiliate selling the products or services (hereinafter referred to as "products") to Buyer (hereinafter referred to as "Seller") 1. Quotations. Unless otherwise indicated on the quote, written quotations by Seller shall expire automatically 90 days after the date appearing on the quotation unless Seller receives and accepts Buyer's purchase order within that period. Prior to the expiration date any quotation is subject to change by Seller at any time upon verbal or written notice to Buyer.

2. Acceptance of Purchase Orders. Notwithstanding any contrary language in Buyer's purchase order, each purchase order shall be subject to acceptance by an authorized employee of Seller and each transaction shall be governed exclusively by these Terms and Conditions of Sale. Such acceptance is expressly limited to these Terms and Conditions of Sale, and any additional or different terms proposed by Buyer are automatically rejected unless expressly assented to in writing by an authorized employee of Seller. All purchase orders accepted by Seller are deemed to be sales for commercial Buyers and shall not, unless plainly and prominently stated on the face of the purchase order, be considered a sale to any federal, state, provincial or municipal governmental entity either domestic or foreign. No contract shall exist except as hereinabove provided.

3. Price Changes. Prices are subject to change to the prices in effect at the time of delivery. Seller reserves the right to make any corrections to prices quoted due to clerical errors or errors of omission. In the event of any design, specification or ordered quantity changes representing a price increase, Buyer will be notified and afforded an opportunity to confirm.

4. Delivery. Lead times are for reference only and are subject to change. Design and/ or specification changes are subject to review for possible adjustments to delivery. Order quantities subject to scheduled delivery dates must be mutually agreed upon.

5. Taxes. Any and all sales, use, or other permissible taxes assessed upon any sale or products sold shall be added to the purchase price of the products.

6. Payment Terms. Payment terms are net 30 days from date of invoice if Seller has approved Buyer's credit.

7. Packaging. The cost of standard bulk packaging for shipment in the United States and Canada is included in Seller's price. Additional charges may be imposed for special domestic packaging, overseas packaging, or special marking performed at Buyer's request and agreed to by Seller.

8. Shipment Terms. Unless Seller agrees otherwise, all shipments shall be freight collect F.O.B. origin (shipping point). Seller shall also be entitled to impose additional charges for the completion, at Buyer's request, of forms with respect to shipping. Unless otherwise agreed, shipment may be made by lots of reasonable commercial size as Seller deems appropriate.

9. Title and Risk of Loss. Risk of loss or damage in transit shall be borne entirely by Buyer at all times after the products are delivered to the carrier for shipment. However, the right to stop delivery in transit shall remain with Seller until payment in full has been received by Seller.

10. Delays or Default in Delivery. Seller shall have no liability to Buyer for Seller's delay or default in delivery due to strikes, secondary boycotts, riots, wars, accidents, fires, floods, explosions, vandalism, government embargoes, priorities or regulations, transportation delays, shortages of labor, fuel, materials, supplies, power, transportation facilities or tooling capacity or other similar or dissimilar causes beyond Seller's reasonable control. Under no circumstances shall Seller have any liability for penalties or other consequential damages of any kind resulting in whole or in part from Seller's delay in delivering, or failure to deliver, any products to Buyer as agreed.

11. Intellectual Property Infringement. With respect to all products manufactured to Buyer's specifications, Buyer shall indemnify and hold Seller harmless from and against any and all loss, cost, expense, claims, demands, suits and judgments arising from actual or alleged infringement of any third party intellectual property right. With respect to all other products sold by Seller, Seller shall defend any suit or proceeding brought against Buyer on claim that such product, or any part thereof, directly infringes any third party intellectual property right, provided that Seller is notified promptly in writing and given all necessary information, assistance and authority to defend the same. Seller shall pay all damages and costs awarded against Buyer as a result thereof. If as the result of such direct infringement, the court enjoins the use of any product, or part thereof, in the manner intended by Seller, Seller shall at its sole expense and option: (a) procure for Buyer the right to continue using said product or part; (b) replace such product or part with a non- infringing product or part; (c) modify said product or part so that it becomes non-infringing; or (d) remove said product or part and refund its purchase price and transportation costs. Seller shall have no further liability for actual or alleged patent infringement except as provided herein.

12. Design and Technical information. Seller claims proprietary rights in the items and information associated with this order. Drawings and technical information are issued in confidence for engineering information and mutual assistance only and may not be publicly disseminated, reproduced or used by Buyer without Seller's prior written consent and shall be returned upon the earlier of Seller's written request or when its purpose has been served.

13. Warranty. Seller's warranty is set forth in Seller's Warranty Policy Number M-HYOV-TB001-E, which can be accessed on the Eaton Hydraulics Product Literature website www.eaton.com/hydraulics/ warranty. THE WARRANTY IS BUYER'S EXCLUSIVE REMEDY AND SELLER HEREBY EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. Seller's warranty shall constitute the sole remedy of Buyer and the sole liability of Seller.

14. Cancellation. Changes and/or cancellations to existing schedules or orders are subject to Seller's acceptance and any applicable cancellation charges (and possible increase in per piece price due to reschedules). Cancellation charges will be determined by the type of product and the stage of completion. Cancellation charges for special products will be based on the selling price less amounts saved at the time of cancellation. Seller will accept temporary holds on orders for rescheduling purposes for a period not to exceed 30 days. If at that time a reschedule is not received, Seller reserves the right to recommence shipments in accordance with the original schedule or cancel the order.

15. Returns. No products shall be returned to Seller, whether for inspection, repair, replacement, or any other reason, without prior written approval from Seller. Products and parts must be returned in new or like new condition with complete identification in accordance with Seller's instructions or the shipment may not be accepted. All returns must be sent to Seller freight prepaid F.O.B. destination unless otherwise instructed. Where written authorization has been obtained to return products and parts for reasons beyond warranty, a restocking charge of twenty five percent (25%) and any additional transportation charges are applicable.

16. Minimum Order. Minimum order amount is $100.00.

17. Remedies. Any lawsuit or legal claim for breach of this order must be brought within one year after the breach occurs.

18. Currency. Unless otherwise indicated on the invoice, all payments are to be made in United States dollars.

19. Governing Law. The terms and conditions of this agreement shall be construed according to the laws of the state of Ohio.

20. Limitation of Liability. THE REMEDIES OF THE BUYER SET FORTH IN THESE TERMS AND CONDITIONS OF SALE ARE EXCLUSIVE AND ARE ITS SOLE REMEDIES FOR ANY FAILURE OF SELLER TO COMPLY WITH ITS OBLIGATIONS HEREUNDER. NOTWITHSTANDING ANY PROVISION IN THESE TERMS AND CONDITIONS OF SALE TO THE CONTRARY, IN NO EVENT SHALL SELLER BE LIABLE IN CONTRACT, WARRANTY, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE FOR DAMAGE TO PROPERTY OR EQUIPMENT OTHER THAN PRODUCTS SOLD HEREUNDER, LOSS OF PROFITS OR REVENUE, LOSS OF USE OF PRODUCTS OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF SUBSTITUTE EQUIPMENT, FACILITIES OR SERVICES, DOWNTIME COSTS, DELAYS, CLAIMS OF CUSTOMERS OF THE BUYER OR OTHER THIRD PARTIES OR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, REGARDLESS OF WHETHER SUCH POTENTIAL DAMAGES ARE FORESEEABLE OR IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE TOTAL CUMULATIVE LIABILITY OF SELLER ARISING FROM, CONNECTED WITH, RESULTING FROM OR RELATED TO THESE TERMS AND CONDITIONS OF SALE WHETHER THE CLAIMS ARE BASED IN CONTRACT, WARRANTY, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE, SHALL NOT EXCEED THE PRICE OF THE PRODUCT ON WHICH SUCH LIABILITY IS BASED.

Eaton Industrial Hose
1750 Hardeman Lane
Cleveland, TN 37312
USA
Tel: 1-800-833-3837
FAX: 1-952-974-7513
www.eaton.com/hydraulics

Eaton
Hydraulics Group Europe
Route de la Longeraie 7
1110 Morges
Switzerland
Tel: +41 (0) 21 811 4600
Fax: +41 (0) 21 811 4601

Eaton
Hydraulics Group Asia Pacific
Eaton Building
No.7 Lane 280 Linhong Road
Changning District, Shanghai
200335 China
Tel: (+86 21) 5200 0099
Fax: (+86 21) 2230 7240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