

GUIDELINES - LIABILITY

FORSAFLEX DISCLAIMS ANY RESPONSIBILITY OR LIABILITY FOR ANY CRIMPED HOSE ASSEMBLIES THAT HAVE NOT BEEN MADE EXCLUSIVELY FROM GENUINE FORSAFLEX HOSE, HOSE FITTINGS AND APPROVED EQUIPMENT. THIS IS IN CONFORMANCE WITH CURRENT FORSAFLEX GUIDELINES FOR EACH SPECIFIC HOSE ASSEMBLY.

Forsaflex products are part of an engineered system which must be assembled and used in accordance with Forsaflex instructions and limitations. Forsaflex hose, couplings and crimping machines are a reliable assembly system designed by our engineering group. The use of other than Forsaflex components (hose, couplings, equipment) may produce assemblies that will not meet the rated performance. Failure to follow Forsaflex guidelines could lead to premature hose failures resulting in property damage, serious injury or death.

Forsaflex's limited warranty shall only apply if the customer uses the hose, hose fittings and crimping equipment specifically approved by Forsaflex's engineers.

Forsaflex will not be responsible when interchanging hose and/or couplings with hose and/or couplings with any other manufacturer. Forsaflex's liability ends and customer's begins when data is ignored or altered and products, other than Forsaflex's are assembled together.

Product Liability Responsibility for Such Hose Assemblies Become the Personal Responsibility of the Assembler or the Company Endorsing These Practices.

There is the argument that hoses branded with the same SAE specification are the same and can be interchanged and used with our couplings. That is false! Hose can only be expected to perform to the requirements of SAE when they are assembled with manufacturer approved couplings. This fact is recognized by SAE in their SAE J1273 handbook:

Proper End Fitting – Care must be taken to insure proper compatibility exists between the hose and coupling selected based on the manufactures' recommendation substantiated by testing to industry standards such as SAE J517.

All Forsaflex customers need to recognize the following critical points:

- 1.** The data supplied with the Forsaflex crimper was developed after extensive testing with Forsaflex hose and couplings.
- 2.** The data that Forsaflex supplies is only good with products bearing the Forsaflex name and catalog part number.
- 3.** Forsaflex couplings, used with other manufacturer's hose, will not necessarily produce an acceptable assembly. Hose styles with identical SAE specs, for instance, are not necessarily the same when it comes to performance with Forsaflex couplings.
- 4.** Hose compatibility with various materials is a reference only. The purchaser is responsible for the verification of suitability. Consult Forsaflex if there is any doubt.
- 5.** Minimum burst pressure ratings listed in our catalog, are for reference and design purposes only. Minimum burst pressure ratings give no indication that the product should be used above the indicated rated working pressure.

AIRCRAFT APPLICATION GUIDELINES

There are no Forsaflex products that we would endorse to be used in any aircraft applications. Our hose and coupling (includes belts) product lines are not designed for any types of aircraft, including helicopters, commercial or private airplanes, ultra-light planes and lighter-than-air craft.

If the user violates the above policy by using Forsaflex product on an aircraft application, that user assumes the sole and exclusive responsibility and liability and Forsaflex assumes no responsibility or liability regarding same.

SAE J1273 HYDRAULIC GUIDELINES

Foreword - This SAE Recommended Practice is intended as a guide to consider when selecting, routing, fabricating, installing, replacing, maintaining, and storing hose for fluid power systems. It is subject to change to keep pace with experience and technical advances. For those new to hose use in a fluid-power system, this guide outlines practices to note during each phase of system design and use. Experienced designers and users skilled in achieving proper results, as well as the less experienced, can use this outline as a list of considerations to keep in mind.

Fluid power systems are complex and require extensive knowledge of both system requirements and the various types of hose. Therefore, all-inclusive, detailed, step-by-step instructions are not practical and are beyond the scope of this document. Less experienced designers and users who need more information can consult specialists such as hose suppliers and manufacturers. This guide can improve the communication process.

Safety Considerations - These recommended practices involve safety considerations; note these carefully during all phases of design and use of hose systems. Improper selection, fabrication, installation, or maintenance of hose and hose assemblies for fluid-power systems, may result in serious personal injury or property damage. These recommended practices can reduce the likelihood of component or system failure, thereby reducing the risk of injury or damage.

1. Scope - SAE J1273 provides guidelines for selection, routing, fabrication, installation, replacement, maintenance and storage of hose and hose assemblies for fluid-power systems. Many of these SAE Recommended Practices also may be suitable for other hoses and systems.

2. References

2.1 Application Documents - The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

- a. **SAE J343** - Test and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies
- b. **SAE J514** - Hydraulic Tube Fittings
- c. **SAE J517** - Hydraulic Hose
- d. **SAE J1927** - Cumulative Damage Analysis for Hydraulic Hose Assemblies.

2.1.2 ISO Publication - Available from ANSI, 25 W. 43rd St. New York, NY 10036-8002

3. Definitions - These explanations serve only to clarify this document and are not intended to stand alone. They are presented sequentially, with the former helping to explain the latter.

3.1 Fluid Power - Energy transmitted and controlled using pressurized hydraulic fluids or compressed air.

3.2 Hose - Flexible conductor. In this document, the term hose also may refer to a hose assembly with related accessories used in fluid power applications.

3.3 Hose Fitting or Fitting - Connector which can be attached to the end of the hose.

3.4 Hose Assembly - Hose with hose fittings attached.

3.5 Hose Failure - Occurrence in which a hose stops meeting system requirements.

3.6 Hose Service Life - Length of time a hose meets system requirements without needing replacement.

4. Safety Considerations - Listed in 4.1 to 4.7 are some potential conditions and situations that may lead to personal injury and/or property damage. This list is not necessarily all inclusive. Consider reasonable and feasible means, including those described in this section, to reduce the risk of injuries or property damage.

4.1 Fluid Injections - Fine streams of escaping pressurized fluid can penetrate skin and enter a human body. These fluid injections may cause severe tissue damage and loss of limb.

Consider various means to reduce the risk of fluid injections, particularly in areas normally occupied by

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operators. Consider careful routing, adjacent components, warnings, guards, shields and training programs. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Avoid contact with escaping fluids. Treat all leaks as though pressurized and hot enough to burn skin. Never use any part of your body to check for leaks. If a fluid-injection accident occurs, see a doctor immediately.

DO NOT DELAY OR TREAT AS A SIMPLE CUT! Any fluid injected into the skin must be surgically removed within a few hours, or gangrene may result. Doctors unfamiliar with this type of injury should consult a knowledgeable medical source.

4.2 Whipping Hose - If a pressurized hose assembly blows apart, the fittings can be thrown off at high speed, and the loose hose can flail or whip with great force. This particularly true in compressible fluid systems. When the risk exists, consider guards and restraints to protect against injury.

4.3 Burns from Conveyed Fluids - Most fluidpower media may reach temperatures that can burn the human skin. If there is a risk of burns from escaping fluids, consider guards and shields to prevent injury to prevent injury, particularly in areas normally occupied by operators.

4.4 Fire and Explosions from Conveyed Fluids - Most fluid-power media, including fire resistant hydraulic fluids, will burn under certain conditions. Fluids which escape from pressurized systems may form a mist or fine spray which can flash or explode upon contact with an ignition source. Consider selecting, guarding and routing hose to minimize the risk of combustion. (See section 5 and ISO 3457).

4.5 Fire and Explosions from Static-Electric Discharge - Fluid passing through hose can generate static electricity, resulting in static-electric discharge. This may create sparks that can ignite system fluids in the surrounding atmosphere. When this potential exists, select hose specifically designed to carry the static-electric charge to ground.

4.6 Electrical Shock – Electrocutation could occur if hose conducts electricity through a person. Most hoses are conductive. Many contain metal or have metal fittings. Even nonconductive hoses can be conduits for electricity if they carry conductive fluids.

Be aware of routing or using hose near electrical sources. When this cannot be avoided, select appropriate hose. Non-conductive hoses should be considered. SAE J517 – 100R7 and 100R8, with orange covers marked “Non-conductive”

are available for applications requiring nonconductive hose.

4.7 Mechanisms Controlled by Fluid Power– Mechanisms controlled by fluids in hoses can become hazardous when a hose fails. For example, when a hose bursts, objects supported by fluid pressure may fall, or vehicles or machines may lose their brakes or steering. If mechanisms are controlled by fluid power, consider safe modes of failure that minimize risks of injury or damage.

5.0 Hose Selection and Routing – A wide variety of interacting factors influence hose service life and the ability of each fluid-power system to operate satisfactorily, and the combined effects of these factors on service life are often unpredictable. Therefore, these documents should not be construed as design standards.

For applications outside the specification in SAE J517, SAE J514 or other relevant design standards, performance of hose assemblies should be determined by appropriate testing. Carefully analyze each system. Then design routings and select hose and related components to meet the system-performance and hose-service-life requirements, and to minimize the risks of personal injury and/or property damage. Consider the following factors:

5.1 – System Pressures – Excessive pressure can accelerate hose assembly failure. Analyze the steady-state pressure, and the frequency and amplitude of pressure surges, such as pulses and spikes.

These are rapid and transient rises in pressure which may not be indicated on many common pressure gauges and can be identified best on high-frequency-response electronic measuring instruments. For maximum hose service life, hose selection should be based on system pressure. Hose may be used above its maximum working pressure where reduced life expectancy is acceptable.

SAE J1927 provides one method to help predict wear-reinforced hose service life for a given hydraulic application, where the surge pressure peaks vary, and/or the highest pressure peaks occur infrequently.

5.2 – Suction – For suction applications, such as inlet flow to pumps, select hose to withstand both the negative and positive pressures the system imposes on the hose.

5.3 – External Pressure – In certain applications, such as in autoclaves or under water, the external environment pressures may exceed the fluid pressure inside the hose. In these applications, consider the external pressures, and, if necessary, consult the manufacturers.

5.4 – Temperature – Exceeding hose temperature ratings may significantly reduce hose life. Select hose so the fluid and ambient temperatures, both static and transient, fall within the hose ratings. The effects of external heat sources should not raise the temperature of the hose above its operating maximum temperature. Select hose, heat shields, sleeving and other methods for these requirements, and route or shield hose to avoid hose damage from external heat sources.

5.5 – Permeation – Permeation, or effusion, is seepage of fluid through the hose. Certain materials in hose construction are more permeable than others. Consider the effects of permeation when selecting hose, especially with gaseous fluid. Consult the hose and fluid manufacturers for permeability information.

5.6 – Hose-Material Compatibility – Variables that can affect compatibility of system fluids with hose materials include, but are not limited to: a) Fluid Pressure, b) Temperature, c) Concentration and d) Duration of Exposure.

Because of permeation (see 5.5), consider compatibility of system fluids with the hose, tube, cover, reinforcement and fittings. Consult the fluid and hose manufacturers for compatibility information.

NOTE – Many fluid/elastomer compatibility tables in manufacturer's catalogs show ratings based at room temperature (21°C). These ratings may change at other temperatures. Carefully read the notes on the compatibility tables, and if in doubt, consult the manufacturer.

5.7 – Environment – Environmental conditions can cause hose and fitting degradation. Conditions to evaluate include, but are not limited to: a) Ultraviolet Light, b) Salt Water, c) Air Pollutants, d) Temperature (see 5.4), e) Ozone, f) Chemicals, g) Electricity and h) Abrasion. If necessary, consult the manufacturer for more information.

5.8 – Static-Electric Discharge – Fluid passing through the hose can generate static electricity resulting in static-electric discharge. This may create sparks that can puncture hose. If this potential exists, select hose with sufficient conductivity to carry the static-electric charge to ground.

5.9 – Sizing – The power transmitted by pressurized fluid varies with pressure and rate of flow. Select hose with adequate size to minimize pressure loss,

and to avoid hose damage from heat generation or excessive velocity. Conduct calculations, or consult the manufacturer for sizing at flow velocities.

5.10 – Unintended Uses – Hose assemblies are designed for the internal forces of conducted fluids. Do not pull hose or use it for purposes that may apply external forces for which the hose or fittings were not designed.

5.11 – Specifications and Standards – When selecting hose and fittings for specific applications, refer to applicable government, industry and manufacturer's specifications and standards.

5.12 – Unusual Applications – Applications not addressed by the manufacturer or by industry standards, may require special testing prior to selecting a hose.

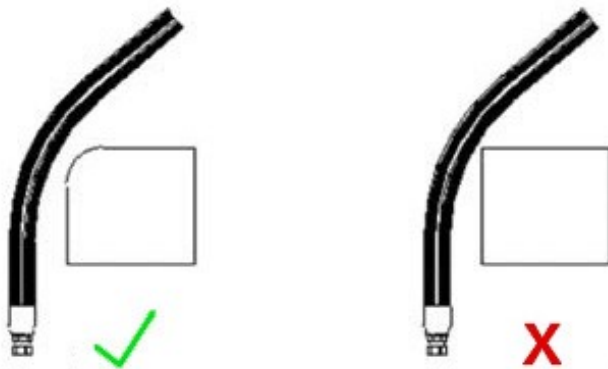
5.13 – Hose Cleanliness – The cleanliness requirements of system components, other than hose, will determine the cleanliness requirements of the application. Consult the components manufacturer' cleanliness information for all components in the system. Hose assemblies vary in cleanliness levels; therefore, specify hose assemblies with adequate cleanliness for the system.

5.14 – Hose Fittings – Selection of the proper hose fittings for the hose and application is essential for proper operation and safe use of hose and related assembly equipment. Hose fittings are qualified with the hose.

Therefore, select only hose fittings compatible with the hose for the applications. Improper selection of hose fittings or related assembly equipment for the application can result in injury or damage from leaks, or from hose assemblies blowing apart. (See 4.2, 6.2, 6.3 and 6.4)

5.15 – Vibration – Vibration can reduce hose service life. If required, conduct tests to evaluate the frequency and amplitude of system vibration. Clamps or other means may be used to reduce the effects of vibration. Consider the vibration requirements when selecting hose and predicting service life.

5.16 – Hose Cover Protection – Protect the hose cover from abrasion, erosion, snagging and cutting. Special abrasion-resistant hoses and hose guards are available for additional protection. Route hose to reduce abrasion from hose rubbing other hose or objects that may abrade it.



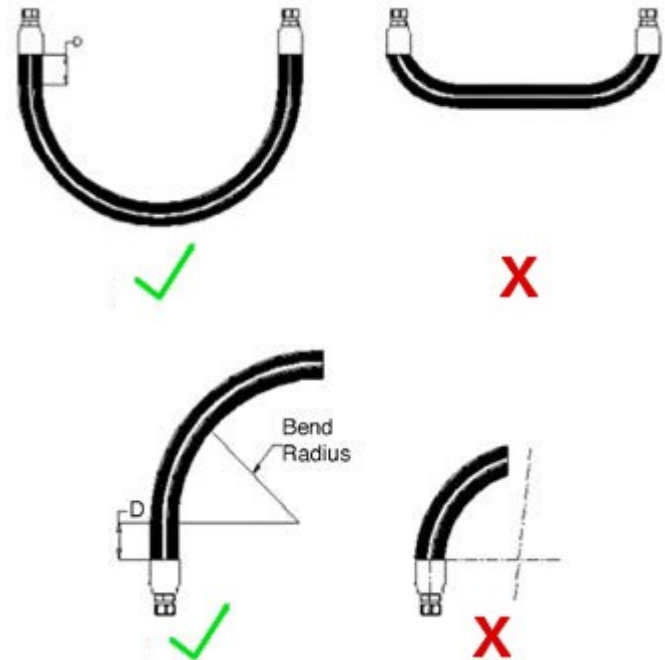
5.17 – Physical Abuse – Route hose to avoid:
 a) Tensile Loads, b) Side Loads, c) Flattening, d) Thread Damage, e) Kinking, f) Damage to Sealing Surfaces, g) Abrasion and h) Twisting.

5.18 – Swivel-Type Adapters – Swivel-type fittings or adapters do not transfer torque to hose while being tightened. Use these as needed to prevent twisting during installation.

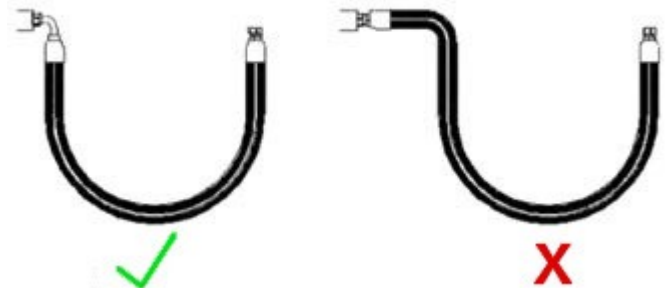
5.19 – Live Swivels – If two components in the system are rotating in relation to each other, live swivels may be necessary. These connectors reduce the torque transmitted to the hose.

5.20 – Slings and Clamps – Use slings and clamps to support heavy or long hose and to keep it away from moving parts. Use clamps that prevent hose movement that will cause abrasion.

5.21 – Minimum Bend Radius – The minimum bend radius is defined in SAE J343 and is specified in other SAE standards and hose manufacturer’s product literature. Routing at less than minimum bend radius may reduce hose life. Sharp bending at the hose/fitting juncture may result in leaking, hose rupturing or in the hose assembly blowing apart.

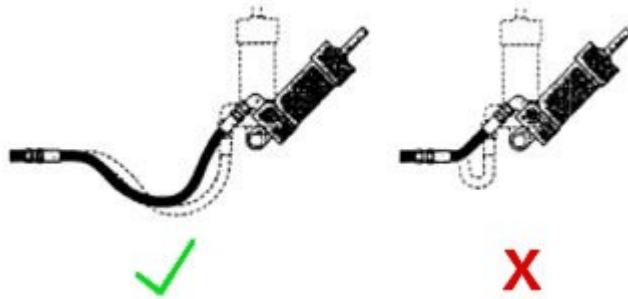


5.22 – Elbows and Adapters – In special cases, use elbows or adapters to relieve hose strain. (See Figure 3).

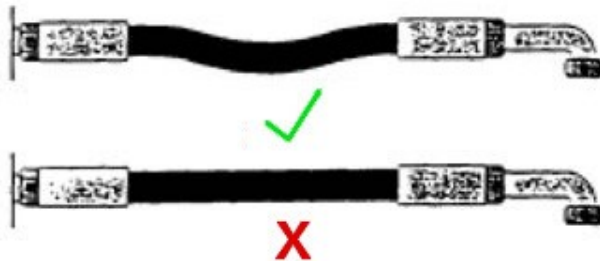


5.23 – Lengths – Unnecessarily long hose can increase pressure drop and affect system performance. When pressurized, hose that is too short may pull loose from its fittings, or stress the fitting connections, causing premature metallic or seal failures.

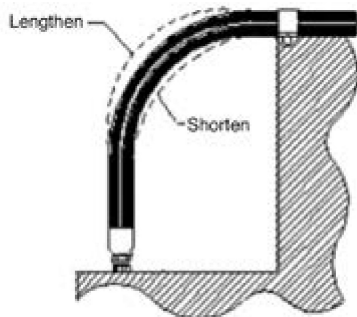
5.23.1 – Motion Absorption – Provide adequate hose length to distribute movement and prevent bends smaller than the minimum bend radius.



5.23.2 – Hose and Machine Tolerances – Design hose to allow for changes in length due to machine motion and tolerances.



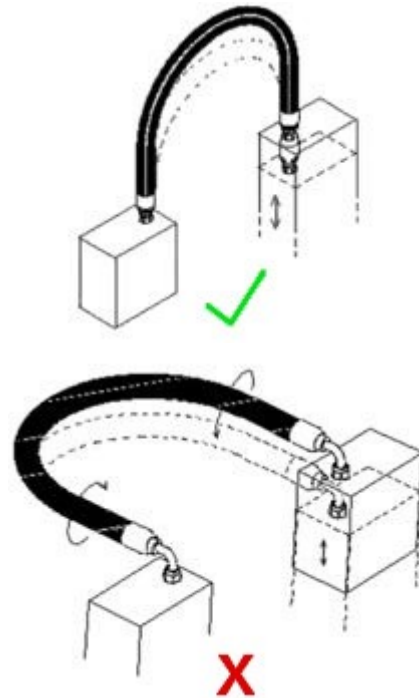
5.23.3 – Hose Length Change Due to Pressure– Design hose to accommodate length changes from changing pressures. DO NOT cross or clamp together high and low pressure hoses. The difference in length changes could wear the hose covers.



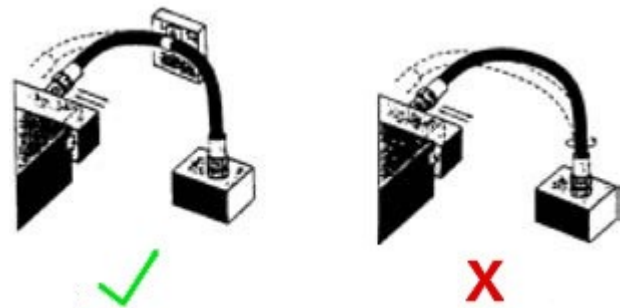
5.24 – Hose Movement and Bending – Hose allows relative motion between system components. Analyze this motion when designing hose systems.

The number of cycles may significantly affect hose life. Also avoid multiple planes of motion and twisting motion. Consider the motion of the hose when selecting hose and predictable service life.

5.24.1 – Bend in Only in One Plane to Avoid Twisting.



5.24.2 – Prevent Hose Bending in More Than One Plane – if the hose follows a compound bend, couple it into separate segments that flex only in one place.



6 Hose-Assembly Fabrication – Persons fabricating hose assemblies should be trained in the proper use of equipment and materials. The manufacturers’ instructions and the practices listed as follows must be followed. Properly assembled fittings are vital to the integrity of a hose assembly.

Improperly assembled fittings can separate from the hose and may cause serious injury or property damage from whipping hose, or from fire or explosion of vapor expelled from the hose.

6.1 – Component Inspection – Prior to assembly, examine components for:

- a) Style or type
- b) Cleanliness
- c) Loose covers
- d) Nicks
- e) Inside obstructions
- f) Size
- g) Visible defects
- h) Damage
- i) Length
- j) Blisters
- k) Burrs

6.2 – Hose Fittings – Hose fitting components from one manufacturer are not usually compatible with fitting components supplied by another manufacturer. For example, do not use a hose fitting nipple from one manufacturer with a hose socket from another manufacturer.

It is the responsibility of the fabricator to consult the manufacturer's written instructions or the manufacturer directly for information on proper fitting components.

6.3 – Hose and Fitting Compatibility – Care must be taken to determine proper compatibility between the hose and the fitting. Base selection on the manufacturer's recommendations substantiated by testing to industry standards, such as SAEJ517.

Hose from one manufacturer is not usually compatible with fittings from another. Do not intermix hose and fittings from two manufacturers without approval from both manufacturers.

6.4 – Hose Assembly Equipment –

Assembly equipment from one manufacturer is usually not interchangeable with that from another manufacturer. Hose and fittings from one manufacturer should not generally be assembled with the equipment of another manufacturer.

6.5 – Safety Equipment – During fabrication, use proper safety equipment, including eye protection, breathing apparatus and adequate ventilation.

6.6 – Reuse of Hose and Fittings – When fabricating hose assemblies, do not reuse:

- a) Field-attachable (reusable) fittings that have blown or pulled off the hose.
- b) Any part of hose fittings that were permanently crimped or swaged to hose.
- c) Hose that has been in service after system checkout.

6.7 – Cleanliness of Hose Assemblies – Hose assemblies may be contaminated during fabrication. Clean hoses to specified cleanliness levels.

7. Hose Installation and Replacement – Use the following practices when installing hose assemblies in new systems or replacing hose assemblies in existing systems:

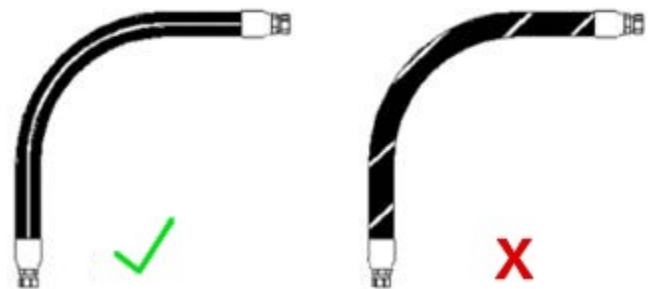
7.1 – Pre-Installation Inspection – Before installing hose assemblies, examine:

- a) Hose length and routing for compliance with original design.
- b) Assemblies for correct style, size, length and visible non-conformities.
- c) Fitting sealing surfaces for burrs, nicks or other damage.

NOTE: When replacing hose assemblies in existing systems, verify that the replacement is of equal quality to the original assembly.

7.2 – Handling During Installation – Handle hose with care during installation. Kinking hose, or bending at less than minimum bend radius may reduce hose life. Avoid sharp bending at the hose/fitting juncture. (See 5.21).

7.3 – Twist Angle and Orientation – Pressure applied to a twisted hose may shorten the life of the hose or loosen the connections. To avoid twisting, use the lay line or marking as a reference (see Figure 9).



7.4 – Securement and Protection – Install necessary restraints and protective devices. Determine that such devices do not create additional stress or wear points.

7.5 – Routing – Review proper routing practices provided in Section 5 and make appropriate corrections to obtain optimum performance.

7.6 – Assembly Torque – The connection end of a hose fitting is normally threaded to obtain tight pressure seal when attached to a port, an adapter or another fitting. Sometimes bolts or screws provide the threaded connection. Each size and type of connection requires different torque values, and these may vary due to type of material or exterior coating. Follow appropriate torquing instructions to obtain a proper pressure seal without overtorquing.

A properly calibrated torque wrench should be used to tighten each connection, except when the manufacturer specifies tightening a specified number of hex flat turns beyond finger tight to obtain a seal.

7.7 – System Checkouts – In hydraulic or other liquid systems, eliminate all air entrapment after completing the installation. Follow manufacturers' instructions to test the system for possible malfunctions and leaks.

7.7.1 – To avoid injury during system checkouts:

- a) Do not touch any part of the system when checking for leaks (see 4.1).
- b) Stay out of potentially hazardous areas while testing hose systems (see Section 4).
- c) Relieve system pressure before tightening connections.

8. Maintenance Inspection – A hose and fitting maintenance program may reduce equipment downtime, maintain peak operating performance, and reduce the risk of personal injury and/or property damage. The user should design and implement a maintenance program that suits a specific application and each specific hose in that application.

8.1 – Inspection Frequency – Evaluate factors such as the nature and severity of the application, past history and manufacturers' information to establish the frequency of visual inspections and functional tests.

8.2 – Visual Inspection (Hose & Fittings) – Visually inspect hose and fittings for:

- a) Leaks at the hose fitting or in the hose
- b) Damaged, cut or abraded cover
- c) Exposed reinforcement
- d) Kinked, crushed, flattened or twisted hose
- e) Hard, stiff, heat cracked or charred hose
- f) Blistered, soft, degraded or loose cover
- g) Cracked, damaged or badly corroded fittings
- h) Fitting slippage on hose

i) Other signs of significant deterioration

If any of these conditions exist, evaluate those hose assemblies for correction or replacement.

8.3 – Visual Inspection (All Other Components) – When visually inspecting hose and fittings, inspect for related items including:

- a) Leaking ports
- b) Damaged or missing hose clamps, guards or shields
- c) Excessive dirt and debris around hose.
- d) System fluid: level, type, contamination, condition and air entrainment.

If any of these are found, address them appropriately.

8.4 – Functional Test – Functional tests determine if systems with hose are leak free and operating properly. Carry out functional tests per information from equipment manufacturers.

9. Hose Storage – Age control and the manner of storage can affect hose life. Use the following practices when storing hose.

9.1 – Age Control – Maintain a system of age control to determine that hose is used before its shelf life has expired. Shelf life is the period of time when it is reasonable to expect the hose to retain full capabilities for rendering the intended service. Store in a manner that facilitates age control and first-in, first-out usage based on manufacturing date on the hose or hose assembly. Per SAE J517:

- a) Shelf life of rubber hose in bulk form, or in hose assemblies passing visual inspection and proof test, is forty quarters (ten years) from the date of manufacture.
- b) Shelf life of thermoplastic and PTFE hose is considered to be unlimited.

9.2 – Storage – Store hose and hose assemblies in a cool, dark, dry area with ends capped. When storing hose, take care to avoid damage that could reduce hose life, and follow the manufacturers’ information for storage and shelf life.

Examples of factors that can adversely affect hose products in storage are:

- | | |
|-----------------------------|---------------------------------|
| a) Temperature | f) Humidity |
| b) Ozone | g) Ultraviolet light |
| c) Oils | h) Solvents |
| d) Corrosive liquids | i) Insects and fumes |
| e) Rodents | j) Radioactive materials |

If there are any questions regarding the quality or usability of hose or hose assemblies, evaluate appropriately:

- a)** Flex the hose to the minimum bend radius and compare it with new hose. After flexing, examine the cover and tube for cracks. If any appear, no matter how small, reject the hose.
- b)** If the hose is wire reinforced, and the hose is unusually stiff, or a cracking sound is heard during flexing, check for rust by cutting away a section of the cover from a sample. Rust would be another reason for rejection.
- c)** If doubt still persists, contact hose assembler to conduct proof-pressure tests or any other tests needed to verify hose quality.