SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1273

REV. AUG2004

Issued 1979-09
Revised 2004-08

Superseding J1273 DEC2002

Recommended Practices for Hydraulic Hose Assemblies

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 fluid-power systems, 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 the 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.

TABLE OF CONTENTS

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: http://www.sae.org

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 Applicable Publications—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.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J343—Test and Procedures for SAE 100 R Series Hydraulic Hose and Hose Assemblies
SAE J514—Hydraulic Tube Fittings
SAE J517—Hydraulic Hose
SAE J1927—Cumulative Damage Analysis for Hydraulic Hose Assemblies

2.1.2 ISO PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 3457—Earth moving machinery—Guards and shields—Definitions and specifications

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 a 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.

Training, including the information in this document, for operators, maintenance personnel, and other individuals working with hoses under pressure is encouraged.

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 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 a hose 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 is particularly true in compressible-fluid systems.

When this risk exists, consider guards and restraints to protect against injury.

4.3 Burns from Conveyed Fluids—Fluid-power media may reach temperatures that can burn human skin. If there is risk of burns from escaping fluid, consider guards and shields 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 or gases in the surrounding atmosphere.

When this potential exists, select hose specifically designed to carry the static-electric charge to ground.

4.6 Electrical Shock—Electrocution 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. Nonconductive hoses should be considered. SAE J517—100R7 and 100R8 hoses, with orange covers marked “Nonconductive” 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. 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 specifications 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 pressures, 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 gages and can be identified best on high-frequency-response electronic measuring instruments.

For maximum hose service life, hose selection should be based on a system pressure, including surges, that is less than the hose maximum working pressure. Hose may be used above its maximum working pressure where reduced life expectancy is acceptable. SAE J1927 provides one method to help predict wire-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 environmental 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 maximum operating 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 fluids. 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
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 manufacturers' catalogs show ratings based on fluids at 21 °C, room temperature. 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
h. Abrasion

If necessary, consult the manufacturers for more information.

5.8 Static-Electric Discharge—Fluid passing through 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 manufacturers 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 hose.

5.13 Hose Cleanliness—The cleanliness requirements of system components, other than hose, will determine the cleanliness requirements of the application. Consult the component manufacturers' 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. (See Figure 1)

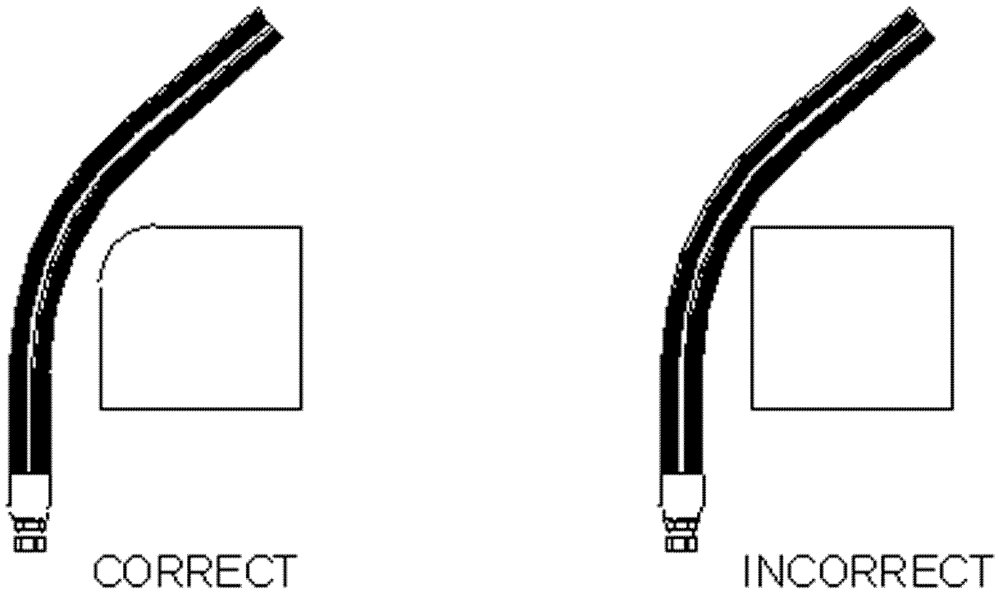

FIGURE 1—PREVENTION OF EXTERNAL DAMAGE

5.17 External 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
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 the hose assembly blowing apart (see 4.2 and Figures 2A and 2B).

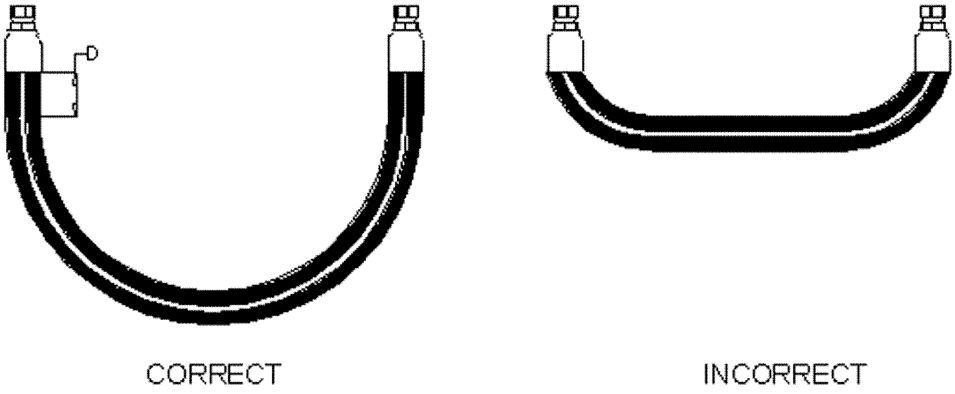

FIGURE 2A—MINIMUM BEND RADIUS

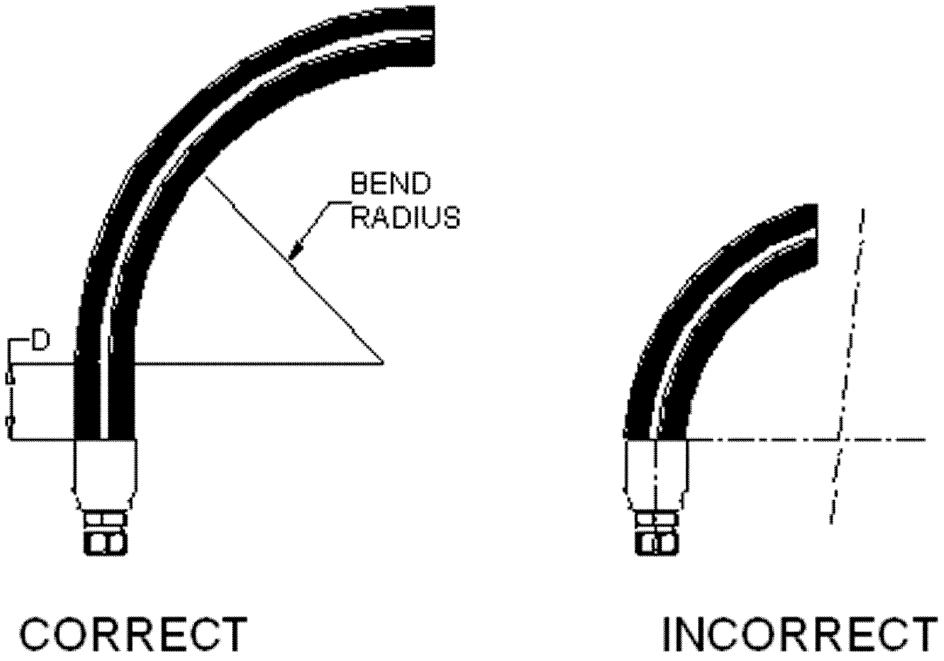

FIGURE 2B—MINIMUM BEND RADIUS

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

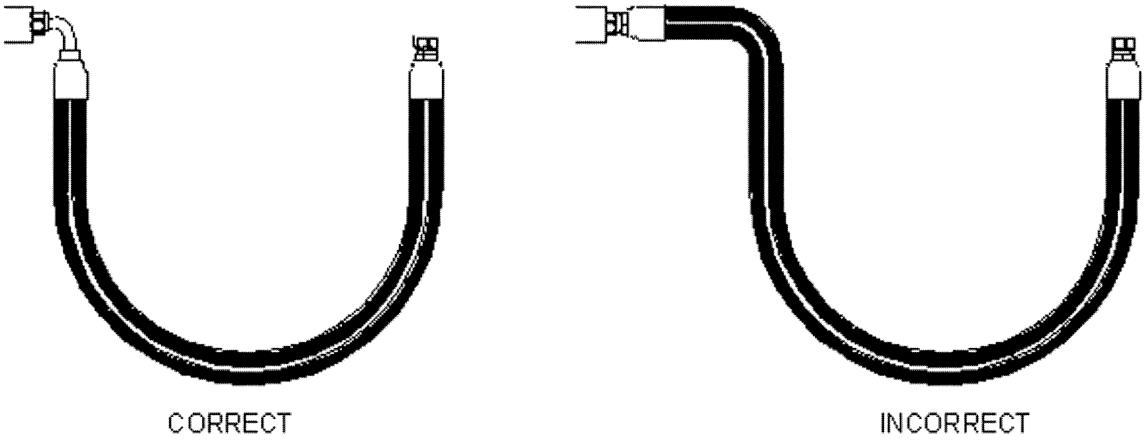

FIGURE 3—ELBOWS AND ADAPTERS

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. When establishing hose length, refer to Figures 4, 5, and 6; and use the following practices:

5.23.1 MOTION ABSORPTION—Provide adequate hose length to distribute movement and prevent bends smaller than the minimum bend radius.

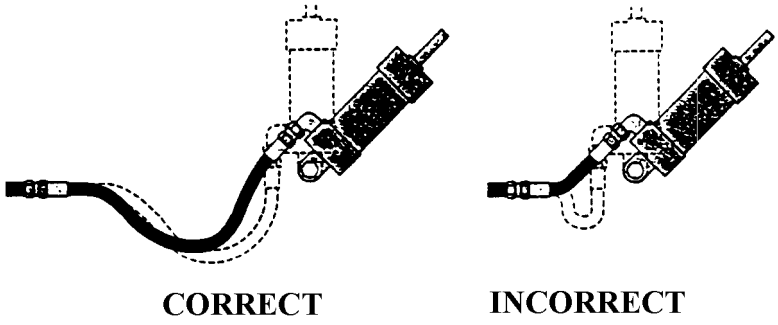

FIGURE 4—MOTION ABSORPTION

5.23.2 HOSE AND MACHINE TOLERANCES—Design hose to allow for changes in length due to machine motion and tolerances.

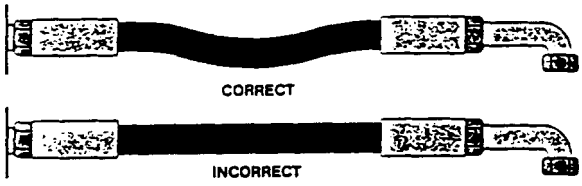

FIGURE 5—HOSE AND MACHINE TOLERANCES

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.

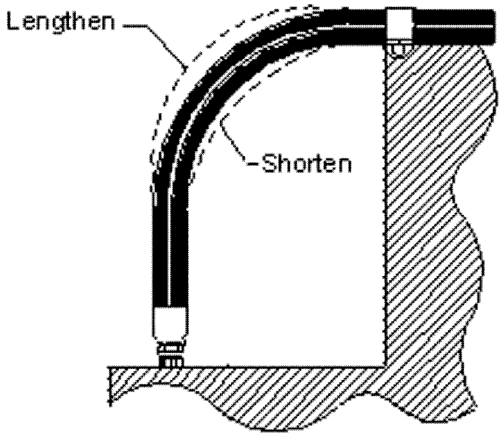

FIGURE 6—HOSE LENGTH CHANGE DUE TO PRESSURE

5.24 Hose Movement and Bending—Hose allows relative motion between system components. Analyze this motion when designing hose systems. The number of cycles per day may significantly affect hose life. Also avoid multiple planes of motion and twisting motion. Consider the motion of the hose when selecting hose and predicting service life. In applications that require hose to move or bend, refer to Figures 7A, 7B, and 8; and use these practices:

5.24.1 BEND IN ONLY ONE PLANE TO AVOID TWISTING

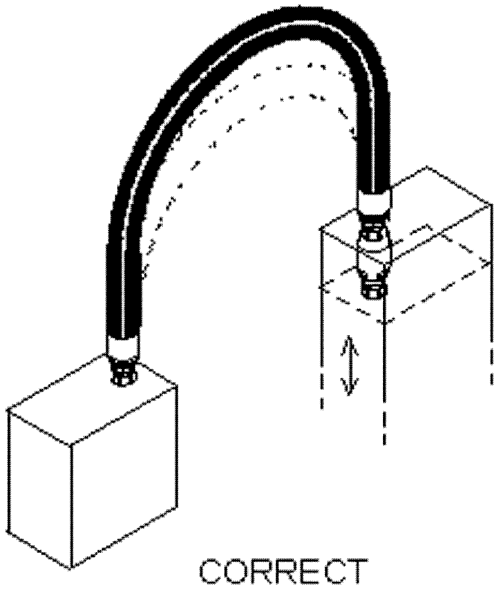

FIGURE 7A—BEND IN ONLY ONE PLANE TO AVOID TWISTING

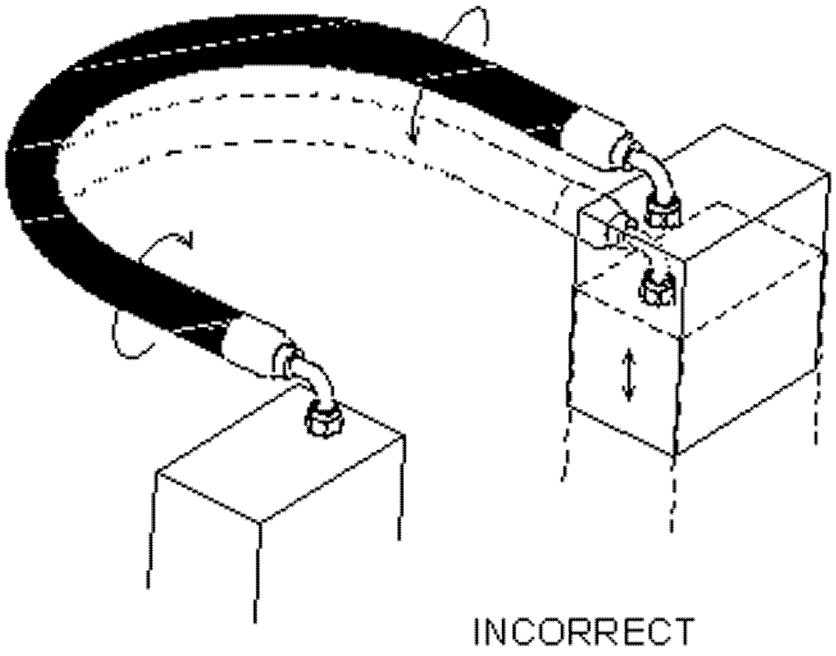

FIGURE 7B—BEND IN ONLY ONE PLANE TO AVOID TWISTING

5.24.2 PREVENT HOSE BENDING IN MORE THAN ONE PLANE—If hose follows a compound bend, couple it into separate segments, or clamp it into segments that flex in only one plane.

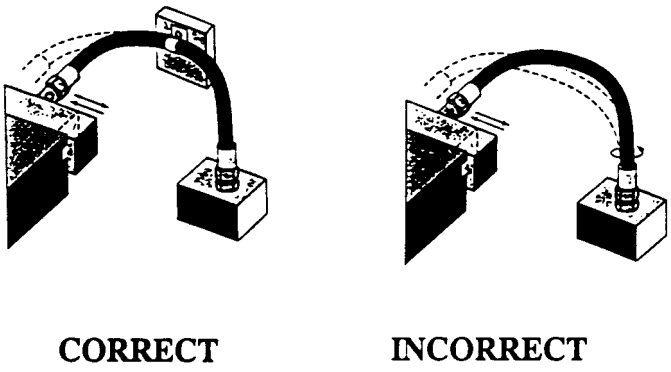

FIGURE 8—PREVENT HOSE BENDING IN MORE THAN ONE PLANE

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. Size
f. Inside obstructions
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 fitting. Base selection on the manufacturers' recommendations substantiated by testing to industry standards such as SAE J517. 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. Hoses 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 fittings that have blown or pulled off 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 (see 7.7)

6.7 Cleanliness of Hose Assemblies—Hose assemblies may be contaminated during fabrication. Clean hoses to specified cleanliness levels (see 5.13).

***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 nonconformities
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 hose lay line or marking as a reference (see Figure 9).

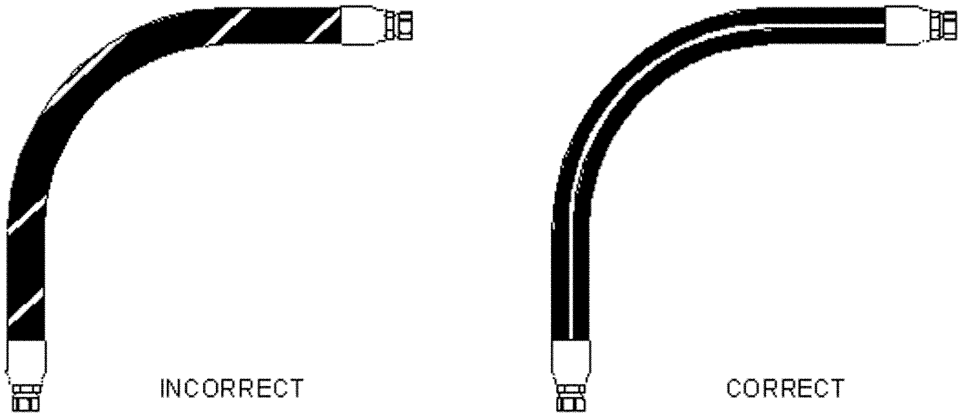

FIGURE 9—TWIST ANGLE AND ORIENTATION

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 a 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 over-torquing. 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 the 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 and Fittings)—Visually inspect hose and fittings for:

a. Leaks at hose fitting or in 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 the 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 hose in a manner that facilitates age control and first-in, first-out usage based on manufacturing date on 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 polytetrafluoroethylene hose is considered to be unlimited.

9.2 Storage—Store hose and hose assemblies in a cool, dark, dry area with the 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
b. Ozone
c. Oils
d. Corrosive liquids and fumes
e. Rodents
f. Humidity
g. Ultraviolet light
h. Solvents
i. Insects
j. Radioactive materials

If there are 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.

10. Notes

10.1 Marginal Indicia—The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

PREPARED BY THE SAE FLUID CONDUCTORS AND CONNECTORS TECHNICAL COMMITTEE SC3—TRAINING AND EDUCATION SUBCOMMITTEE

SAE J1273 Revised AUG2004

Rationale—To correct verbiage in Section 9.1.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—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.

Reference Section

SAE J343—Test and Procedures for SAE 100 R Series Hydraulic Hose and Hose Assemblies

SAE J514—Hydraulic Tube Fittings

SAE J517—Hydraulic Hose

SAE J1927—Cumulative Damage Analysis for Hydraulic Hose Assemblies

ISO 3457—Earth moving machinery—Guards and shields—Definitions and specifications

Developed by the SAE Fluid Conductors and Connectors Technical Committee SC3—Training and Education Subcommittee

Sponsored by the SAE Fluid Conductor and Connectors Technical Committee