SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Application of Hydraulic Brake Hose to Motor Vehicles—Wheel End and Axle

RATIONALE

The Automotive Brake and Steering Hose Standards Committee has reviewed this document and added further details for evaluating the application of hydraulic brake hose to the wheel end and axle on motor vehicles.

FOREWORD

The performance requirements in this SAE Recommended Practice represent the accumulation of the best information available from vehicle, brake hose, and brake hose assembly manufacturers. Since this document is subject to frequent change in order to keep pace with experience and technical advances, inclusion in any regulations where flexibility of revision is impractical is not recommended.

1. SCOPE

This SAE Recommended Practice covers the application of hydraulic brake hose (as defined by current issue of SAE J1401) as used to provide a flexible hydraulic connection between wheel end or axle brake system components on motor vehicles.

1.1 Purpose

The purpose of this document is to outline design, operating, and service factors in routing a hydraulic brake hose assembly to a vehicle. It is intended to serve as a recommended practice for original equipment manufacturers. Vehicle design circumstances may exist that prevent strict adherence to this document. Any deviations should have the concurrence of all engineering functions involved.

2. REFERENCES

2.1 Applicable Publication

The following publication forms a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE Publication

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1401 Road Vehicle—Hydraulic Brake Hose Assemblies for Use with Nonpetroleum-Base Hydraulic Fluids

3. DEFINITIONS

3.1 Full Jounce Position

The attitude of the front or rear suspension compressed to metal-to-metal contact, with all rubber components of the suspension removed.

3.2 Full Rebound Position

The attitude of the front or rear suspension extended to the limit of travel permitted by the shock absorbers or other restrictions.

3.3 Full Right or Left Steer Position

The position at metal-to-metal steering system stops.

3.4 Extremes of Travel

Extremes of travel include the full jounce and rebound positions, full right and left steer positions and new and fully worn brake pads using tire and wheel combinations or templates to produce the most adverse clearance condition. Full effect of all suspension alignment positions of caster, camber and tow may also be considered where applicable.

4. OBJECTIVES

4.1 Provide sufficient clearance to other components; i.e., tire chains, all tire/wheel sizes and configurations, drive shaft, etc. with all components in place: i.e. sensor cables.

4.2 Protect from exposure to adverse conditions such as heat, petroleum products, battery fluid, etc.

4.3 Minimize tension, severe bends, twist, and length.

4.4 Minimize exposure to mechanical damage due to operating the vehicle over underbrush, bumps, loose gravel, sand, mud, snow, ice, ruts, etc.

4.5 Minimize possibility of damage to hose during brake and other component assembly to vehicle.

4.6 Minimize potential for improper installation.

5. DESIGN FACTORS

5.1 Tire/Wheel Clearance

Because of the potential for failure caused by wear through, it is extremely important not only to route the hose for adequate tire, tire chain, suspension and chassis component clearances, but also to assure that dynamic factors do not induce interference.

To reduce the likelihood of unanticipated interference, it is recommended that the designer establish the most “natural” path from caliper (or wheel cylinder) or intermediate support point to the bracket on frame or body. This will tend to avoid configurations which may cause the hose to suddenly take a new position when influenced by suspension motion and torsional effects. The sequence of motion or the rate of change may be the dominant factor, e.g., if the left-hand wheel moves from rebound to jounce in left steer and then to right steer, a twist in the hose might produce interference with the tire, whereas the opposite sequence (steer first, then elevate to jounce) would not cause hose-to-tire interference. Hose routings that produce a tight “S” curve are especially susceptible to a change in hose relative position, e.g., the unsupported portion of the hose is capable of maintaining more than one stable position (generally “looped”) depending on the sequence of suspension/steering motions just preceding these positions. If a hose takes a “looped” position it should return to its natural routing path after either one left to right steering cycle or one jounce to rebound suspension cycle.

5.2 Dynamic Effects

Although adequate clearance may be obtained under static conditions, operating the vehicle over rough or “washboard” surfaces may produce hose contact with wheel/tire, suspension or chassis components, especially where long lengths of unsupported hose or looped sections are involved. If contact can occur, mechanical protection as described in Section 6 should be added. Road simulator equipment may be useful to investigate hose resonant effects by observing hose motion at varying frequencies.

5.3 Tension

Tension may be inherent in brake hose routings and should be minimized. The “fixed” frame or body attachment point for the hose is usually selected to balance full jounce position and full rebound position tensions, if other conditions permit.

5.4 Severe Bends

Severe bends may be inherent in brake hose routings and should be minimized. In some routings, for example, where an intermediate attachment of the hose is made between end connections, a section of the hose may be in compression. Aside from inconvenience in attaching the hose assembly to the vehicle, compressive force is not detrimental to the hose, but the hose should be evaluated for this compressive force affect through durability tests or simulations.

5.5 Twist

Twist may be inherent in hose attachment but should be minimized. Steering and/or suspension movements may accent the twist characteristic. Depending upon the design and type of suspension, a change in twist may also be minimized by vertical orientation of the fixed end connection.

5.6 Length

Length is determined by extremes of relative movement of the hose assembly and connection points. The two connection points are located by consideration of the following factors: clearance, manufacturing feasibility (vehicle assembly), vehicle servicing, vertical and rotational (steering) movement of the wheel, and location of tie rod, suspension spring, shock absorber (strut or damper), suspension control arm, etc. Length may need to be adjusted to limit the minimum bend radius and/or minimize tension.

5.7 Trapped Fluid Systems (Sustained High Pressure)

Vehicle manufacturer's recommendations should be considered in any hydraulic brake hose application in which brake fluid can be trapped and result in sustained pressure, as in hydraulic parking brake, antitheft, or antilock brake systems.

5.8 Heat

Deterioration of brake hose is generally a direct function of temperature over time. Within the space limitations of the routing envelope, exposure to heat sources (engine compartment, exhaust manifold, catalytic converter, muffler, and pipe system) may be minimized by hose location or shielding. Consideration should be given to prevent the exposure of the brake hose to heat due to an exhaust system failure.

5.9 Cold

Little can be done by means of routing to protect the hose from the effects of extreme cold beyond avoiding tight bends.

5.10 Installation

Fittings, brackets, and mating components should be designed to optimize correct installation to the vehicle and avoid operator sensitive conditions.

6. DESIGN VERIFICATION

Static design verification should be performed on vehicles manufactured to the extremes of the tolerance range. Since it is impractical for the vehicle manufacturer to build vehicles to the extremes of the vehicle tolerance range, it may be desirable to verify prototype, pilot build, and early production vehicles to consider the effects of vehicle design tolerance ranges. In addition, it is advisable to perform durability tests to verify no adverse effects due to vehicle dynamics.

The static design verification should be performed for all combinations of the extremes of travel using hose assemblies that encompass the extremes of the assembly length and end fitting orientation tolerance ranges.

Recommended guidelines for static design verification are:

a. Minimum hose outside diameter bend radius: 25 mm

b. Minimum hose clearance to rotating components: 19 mm

c. Minimum hose clearance to nonrotating components: 13 mm

d. Where contact between hose and other components is positively prevented by a stop, minimum clearance: 5 mm

e. Minimum hose clearance to heat sources: 25 mm

f. Hose should not be taut in any position as demonstrated by the ability to physically rotate the center section of the hose about a 25 mm swing radius with approximately 13 N force.

Mechanical means may sometimes be added to the brake hose exterior to avoid abrasion when touch conditions are expected to occur during extremes of travel, or to direct the hose to improve clearances. These devices may include, but not be limited to rings, helixes, or sleeves.

7. OPERATING FACTORS

Some factors to which the hose assembly may be exposed in operation are:

a. Mud—If in splash path

b. Water—Rain water and salt water

c. Slush—Ice and snow with or without salt and/or cinders and sand

d. Road oil

e. Sun and ultraviolet exposure

f. Ozone

g. Detergent, degreaser, wax, hot water, and steam—Vehicle wash operations

h. Rustproofing and undercoating materials—Depending on proximity to the surfaces being treated or ease of protecting during undercoating

i. Road debris—If practicable, the brake hose should be routed to be protected by less vulnerable chassis components. For off-road vehicles this would include ruts, underbrush, tree stumps, tree branches, rocks, sand, gravel, barbed wire, etc. This guideline may be satisfied by keeping the lowest part of the hose above the wheel axis or skid plate.

The routing should be evaluated for effects of foreign material accumulating on the hose assembly such as fluid accumulation in sleeves which could accelerate corrosion of end fittings.