

should substantially decrease the likelihood of brake hose failure. NHTSA welcomes comments, however, regarding the appropriateness of applying SAE J1401's requirements/specifications to all hydraulic brake hoses, regardless of their end use or whether they are OEM hoses or replacement hoses.

A detailed discussion of the differences between the hydraulic brake hose performance requirements and test procedures in SAE J1401 and FMVSS No. 106 follows, along with the agency's proposed resolution of those differences.

1. Pressure Test

SAE J1401 specifies a test pressure of 1,500 psi minimum and 2,100 psi maximum for inert gas or air tests and 3,000 psi minimum and 3,500 psi maximum for water and brake fluid tests, with the hose assembly required to sustain these pressures for 10 to 20 seconds, as a preconditioning test for all samples of hose assemblies to be subjected to further test conditions. The burst test (following the expansion test; *see* S5.3.2) specifies a minimum requirement of 4,000 psi plus zero (0) minus 200 psi for 2 minutes, using water or brake fluid, followed by a pressure increase to the point of failure. The minimum failure for $\frac{1}{8}$ inch hose is 7,000 psi and for $\frac{3}{16}$ inch hose is 5,000 psi. SAE J1401 does not specify test conditions for hose sizes other than $\frac{1}{8}$ or $\frac{3}{16}$ inch.

In contrast, FMVSS No. 106 specifies a water pressure test of 4,000 psi for 2 minutes and 5,000 psi minimum burst strength. The performance requirements and test procedures are similar to those in SAE J1401, although FMVSS No. 106 includes a lower pressure requirement for $\frac{1}{8}$ inch hose (5,000 psi) and includes requirements for hose with inside diameters of $\frac{1}{4}$ inch or larger.

NHTSA tentatively concludes that a higher, 7,000 psi burst strength requirement should be adopted for $\frac{1}{8}$ inch and 3mm hydraulic brake hoses. NHTSA contacted Intertek Testing Services, a company that has performed compliance testing of brake hoses under contract to the agency, to determine if the 7,000-psi pressure has been sustained by brake hoses in past testing. Intertek indicated that it typically will test up to 10,000 psi for all sizes of hydraulic brake hose, and that the hose have consistently been able to sustain this much pressure without bursting. Therefore, NHTSA proposes that the 7,000 psi burst strength requirement from SAE J1401 be adopted into Standard No. 106 for $\frac{1}{8}$ inch and 3 mm hydraulic brake hoses.

2. Constriction

SAE J1401's constriction requirement is limited to hydraulic brake hose with an internal hose diameter of $\frac{1}{8}$ inch or $\frac{3}{16}$ inch. SAE J1401 specifies a minimum pass-through diameter of 64 percent of nominal internal hose diameter, which is determined by performing a plug gage test. FMVSS No. 106 contains the same 64 percent of nominal internal hose diameter requirement, but applies it to hose of all sizes, not just hose with an internal hose diameter of $\frac{1}{8}$ inch or $\frac{3}{16}$ inch. Unlike SAE J1401, however, FMVSS No. 106 does not specify a test for determining hose's minimum pass-through diameter. In addition, FMVSS No. 106 explicitly excludes those portions of end fittings that do not contain hose from the constriction test while SAE J1401 does not. NHTSA welcomes comments on the issue of whether the constriction exclusion for portions of end fittings that do not contain hose is still necessary, or if there have been any substantial changes to brake systems which preclude the use of intentionally-restrictive end fittings.

NHTSA proposes retaining the existing constriction performance requirement in FMVSS No. 106 and adding a constriction test procedure. Two different constriction test procedures are available: the drop-ball test and the plug gauge test. In the drop-ball test, a steel ball with a diameter equal to the minimum constriction diameter for a particular hose size is dropped into one end of the hose at its fitting. Gravity is the only downward force acting on the ball, and friction between the hose and ball may not be sufficiently overcome in all tests.

As noted above, SAE J1401 specifies use of a plug gauge test. In the plug gauge test, a cylindrical plug with a small rod handle is inserted into and removed from the hose. NHTSA proposes specifying a plug gauge test because the agency tentatively concludes that the additional weight of the plug gauge may make it less susceptible to friction than the ball used in the drop-ball test. The plug gauge test that NHTSA is proposing, the details of which are contained in paragraph S6.12 of the Proposed Regulatory Text, differs somewhat from the plug gauge test specified in SAE J1401 in two respects. First, the spherical end of the plug gauge must be able to enter the hose or end fitting by applying a force no greater than gravity. Second, the plug gauge must fall under the force of gravity within 3 seconds. The agency welcomes comments both on its proposal to specify a plug gauge test instead of a

drop-ball test and on the differences between the plug gauge test specified in SAE J1401 and the one the agency is proposing.

3. Volumetric Expansion

Both SAE J1401 and FMVSS No. 106 have similar requirements/procedures; however, SAE J1401 does not specify tests for hoses other than $\frac{1}{8}$ or $\frac{3}{16}$ inch. FMVSS No. 106 includes requirements for hoses smaller than $\frac{1}{8}$ inch, larger than $\frac{1}{4}$ inch, and also for metric nominal hose sizes. NHTSA does not propose to make any changes to the volumetric expansion requirements/procedures in FMVSS No. 106.

4. Whip Resistance Test

The whip resistance requirements/procedures for hydraulic brake hose in SAE J1401 and FMVSS No. 106 are similar. Both SAE J1401 and FMVSS No. 106 specify that a hydraulic brake hose assembly shall not rupture when run continuously on a flexing machine for 35 hours. The test procedures differ, however, regarding the level of water pressure to be exerted in conducting the whip resistance test. While FMVSS No. 106 specifies a constant minimum water pressure of 235 psi during the test, SAE J1401 specifies a water pressure range of 225 to 250 psi. The agency does not propose any changes to Standard No. 106's existing test procedures for whip resistance because the existing specifications are so close to the upper pressure limit specified in SAE J1401.

5. Tensile Strength

FMVSS No. 106 specifies that a hose assembly shall have a minimum tensile strength of 325 pounds when pulled at a rate of 1 inch per minute. SAE J1401 includes this same specification, but also specifies an additional tensile strength of 370 pounds when pulled at a faster, 2 inches per minute, rate. Therefore, SAE J1401's test environment is more severe than that specified in FMVSS No. 106. NHTSA proposes that the SAE J1401 fast-pull test and 370 pound strength requirement be incorporated into FMVSS No. 106. The agency also proposes to update the ASTM reference for tension testing machines to the latest version of the standard practice.

6. Water Absorption and Pressure Test, Tensile Strength, and Whip Resistance

Both SAE J1401 and FMVSS No. 106 have identical specifications for the conditioning of the hose assembly in water for 70 hours, but the subsequent test conditions (which are also used for non-water conditioned hose) vary, given the aforementioned differences between