

perpendicularly to the hose centerline at a rate of 600 cycles per minute, with $\frac{1}{2}$ inch of slack in the hose. The hose is subjected to 120-psi air pressure during the test, and the test chamber temperature is initially 220 degrees F. After 250,000 cycles, the temperature is decreased to minus 40 degrees F. This temperature cycle is repeated after 500,000 cycles. The hose assembly is instrumented to measure leakage during the test. There are two performance requirements. First, the assembly must not leak at a rate greater than 50 cm³ per minute at minus 40 degrees F or greater than 25 cm³ per minute at 75 degrees F. Second, the attaching nut at each fitting cannot move when 20 percent of the original tightening torque is re-applied to the nut. FMVSS No. 106 has a leak test (S8.7), but it does not specify preconditioning of the hose by vibration, temperature, or other means, nor does it address fitting tightness after such conditioning. End fitting nut tightness is applicable to end fittings that can be disassembled such that new sections of tubing can be used with the existing fitting components, other than the compression sleeve and the tube support that are renewed when new tubing is installed. Swaged or crimped, permanently-attached fittings which cannot be disassembled for reuse, and push-to-connect fittings which can be reused but do not use a nut to secure the hose or tubing, are exempt from the nut tightness requirement.

The SAE J1131 performance requirements/test procedures ensure adequate end fitting performance to resist vibration and temperature cycling. NHTSA proposes that most of these performance requirements/test procedures be incorporated into FMVSS No. 106.

5. Proof and Burst Test

SAE J1131 specifies proof and burst tests to evaluate end fitting retention. The test apparatus includes a suitable hydraulic pressure source of an unspecified medium. Tubing samples are prepared with 12 inches of free hose length along with the fittings to be evaluated. One end of the assembly is plugged and the other end is attached to the pressure source. At a temperature of 75 degrees F, the pressure is increased to proof pressure and held for 30 seconds. The proof pressure is defined as one-half of the burst pressure specified in SAE J844. Pressure is then increased at a rate such that the specified burst pressure is achieved within 3 to 15 seconds. The fittings must not separate from the tubing and no visible leaks are permitted at less than the specified burst pressure. While

FMVSS No. 106 contains leakage and burst performance requirements/test procedures, as detailed above, the burst pressures specified are lower than those in SAE J844 or SAE J1131. NHTSA proposes to incorporate the proof and burst test from SAE J1131 into FMVSS No. 106 so that there will be a specific test to evaluate the performance of end fittings used with plastic tubing. NHTSA proposes that this test be conducted using water, as this is the test fluid used for the burst strength test for air hoses in FMVSS No. 106.

6. Serviceability Test

SAE J1131 specifies a serviceability test to evaluate end fitting performance for reusable fittings after repeated assembly and disassembly. Tubing samples are prepared with 12 inches of free hose length, following the fitting manufacturer's recommendations for assembly of the end fittings. The fittings are then disassembled and reassembled a minimum of five times. The tubing assembly is then subjected to 120 psi of air at 75 degrees F, with resulting leakage not greater than 25 cm³ per minute.

When flanged-sleeve fittings have been fitted in a plastic tubing assembly that requires replacement, the old tubing is removed by loosening the retaining nut on the fitting. A new section of tubing is cut from a bulk supply of tubing, new ferrules (compression sleeves that fit on the outside of the tubing) and tube supports (internal sleeves that fit inside the tubing) are installed at each end of the replacement tubing, and the new tubing is installed. The other components of the end fittings can be reused. For other types of repairs, such as replacement of a valve to which the tubing is connected, the tubing is disconnected in the same way. The portion of the fitting that threads into the valve can be removed and reinstalled on the replacement valve, and the tubing can then be reinstalled on the new valve using the existing ferrule that remains permanently attached to the tubing. The serviceability performance requirements/test procedures in SAE J1131 are a measure of the fitting's suitability for repeated assembly and disassembly similar to the example of valve replacement when all parts of the end fitting are reused.

Another type of end fitting is the push-to-connect fitting, which when used in an assembly, the end of the tubing is simply pushed into the fitting. To remove the tubing for repair purposes, a ring on the fitting around the outside of the tubing is raised to release the tubing, which can then be

pulled out of the fitting. All information the agency has collected on this type of fitting indicates that the tubing may or may not be damaged upon removal from the fitting, depending on such factors as how much air pressure and pulling force the assembly has been subjected to during its use. If the tubing is damaged, a small section cut off for subsequent reassembly if there is a sufficient slack available in the assembly. If there is not enough tubing length to cut the end off for reassembly, then a new section of tubing will need to be installed. If the O-ring in the push-to-connect fitting is also damaged, it may be serviced or the entire fitting will need to be replaced. This would have to be detected by the technician checking for leakage after reassembly.

NHTSA proposes that the serviceability test be included in Standard No. 106 for those fittings that use a threaded retaining nut. This will ensure that the fittings can be separated and reused during servicing of brake system components with minimal likelihood of leakage upon reassembly. NHTSA does not believe the serviceability test could be consistently applied to push-to-connect fittings and therefore does not propose to include them in this test.

7. Fitting Compatibility Test

SAE J1131 specifies that test specimens be prepared according to the fitting manufacturer's recommendations, with 12 inches of free hose length. The assembly is filled with hydraulic fluid at atmospheric pressure and conditioned at 200 degrees F for 24 hours. The pressure is then increased to 450 psi for 5 minutes after which time the pressure is reduced to atmospheric levels and the assembly is cooled to 75 degrees F. Following this, the tubing assembly is cooled to minus 40 degrees F with the fluid at atmospheric pressure for 24 hours after which time the pressure is increased to 450 psi for 5 minutes. The tubing must not rupture or disconnect from the fittings. Standard No. 106 does not have a corresponding set of test procedures/performance requirements. Accordingly, NHTSA proposes to incorporate the fitting compatibility test and performance requirements from SAE J1131 into FMVSS No. 106.

8. Constriction

FMVSS No. 106 requires that each air brake hose assembly shall be not less than 66 percent of the nominal ID of the hose, except for those portions of end fittings that do not contain hose. SAE J1131 does not contain a corresponding requirement. As discussed in greater