



SURFACE VEHICLE INFORMATION REPORT

J2671™

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Reduced Effort Brakes and Reduced
Effort Vacuum Powered Brake Backup Systems

RATIONALE

SAE J2671 has been reaffirmed to comply with the SAE Five-Year Review policy.

A reaffirmed status is given to technical reports that have been reviewed by the technical committee and deemed to be current with no need for immediate revision. No changes have been made to this document as a result of this review.

1. Scope, Classification, and Limitations

1.1 Scope

This Information Report relates to a special class of automotive adaptive equipment which consists of modifications to the power brake booster systems provided as original equipment of motor vehicles. These modifications are generically called "Reduced Effort Power Brakes" (REPB). The purpose of the modification is to lower the amount of driver effort required to apply the brakes. Retention of reliability, ease of use and maintainability for disabled drivers, passengers, and the general public is of primary concern. Reduced Effort Power Brake modifications should be qualified by the tests referenced in the Recommended Test Procedure. The tests set forth in that procedure should be applied, and failure of a Reduced Effort Power Brake modification to meet those tests should disqualify the modification from the claim of meeting the specifications of this Information Report. Because this is an Information Report, the numerical values for performance measurements presented in this report and in the accompanying Test Procedure, while based upon the best knowledge available at the time, have not been validated by a testing of the Test Procedure.

1.2 Classification

Brake modifications discussed in this Information Report can be classified as any modification to, or replacement of, the OEM power booster such that the reaction force to the driver is reduced.

1.3 Limitations

These standards are limited to modifications which retain an OEM pedal and associated linkage, the OEM master cylinder and all plumbing down to and including the brake wheel cylinders or actuators. They include adaptive equipment modifications for backup systems. Specifically excluded are hydrovac systems and modifications which use externally powered devices to reduce the braking effort.

Rationale: "Joystick" or servo type hand controlled systems which supplant the stock system or a major part of the stock system are out of scope.

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2. References

2.1 Applicable Documents

The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

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

SAE J656—Automotive Brake Definitions and Nomenclature
SAE J299—In Service Brake Performance Test—Passenger Car and Light Duty Trucks
SAE J843d—Brake System Road Test Code—Passenger Car and Light Duty Trucks
SAE J937b—Service Brake System Performance Requirements—Passenger Car
SAE J155—Service Brake System Performance Requirements—Light Duty Trucks
SAE J299—Stopping Distance Test Procedures
SAE J1808—Vacuum Power Assist Brake Booster Test Procedure
SAE J1211—Recommended Environmental Practices for Electronic Equipment Design

2.1.2 MILITARY PUBLICATIONS

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094

MIL-STD-1472 (current revision)—Department of Defence Design Control Criteria Standard: Human Engineering

2.1.3 NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Available from NHTSA, U.S. Department of Transportation, 400 7th Street SW., Washington, D.C. 20590. Federal Motor Vehicle Safety Standards (FMVSS), Part 49, CFR 571. web site: www.nhtsa.dot.gov.

FMVSS No. 105—Service, Emergency, and Power Brakes
FMVSS No. 106—Brake Hoses
FMVSS No. 135—Passenger Car Brake Systems
Part 595—"Exemptions from the Make Inoperative Prohibition; Final Rule"

3. Definitions

3.1 Accumulator Tank

See Vacuum Tank.

3.2 Actuator

A transducer whose output is a force or torque and usually involves motion.

3.3 Automotive Adaptive Equipment

A piece of equipment designed to enable a person with a physical disability to operate a motor vehicle.

3.4 Anomaly

Deviation from the common rule or type; irregularity.

3.5 Auxiliary

See Backup.

3.6 Backup

Any device which duplicates or otherwise fulfills the function of another if the latter fails or become inoperative.

3.7 Booster

Any device for increasing power or output.

3.8 Diaphragm

A flexible disc or membrane which deflects under pneumatic or hydraulic pressure and, in doing so, imparts linear motion to a centrally located rod or other form of mechanical actuator, as in an air or brake carburetor.

3.9 Feedback

The recycling of a portion of the output to the input of a system. Systems employing feedback are called closed-loop systems.

3.10 Logo

A manufacturer's name or trademark.

3.11 Original Equipment

See OEM

3.12 OEM

Original Equipment Manufacturer. This refers to the vehicle, and its systems, as they are designed and produced by the automobile manufacturer.

3.13 Pedal Reserve

The distance, measured from the under surface of the pedal to the floorboard along a line normal to the plane of the brake pedal, when the brake pedal has been depressed to the point of brake lockup or activation of anti-lock brake system.

3.14 Primary

Occurring first in time or sequence. Pertaining in the context of this document to the system which is intended to be in operation normally or routinely.

3.15 Power Brake Backup System

Refers to a system which provides backup to the modified or unmodified OEM brake boost system.

3.16 Reduced Effort Brakes

A modification to the OEM power brake system which reduces pedal effort.

3.17 Shall

The term to be used whenever the criteria for conformance with the specific recommendations requires that there be no deviation. (SAE J1159). (Note: Because this is an Information Report which makes recommendations, but is not standards, the use of the word shall has been replaced by should elsewhere in the report.)

3.18 Should

The term to be used whenever non-compliance with the specific recommendation is permissible. (SAE J1159)

3.19 Single-Point Failure

Any failure of a component which directly causes the system, of which the failed component is a part, to cease to function.

3.20 Transducer

A device which converts energy from one form or power level to another.

3.21 Vacuum Tank

Usually a cylindrical container from which air has been partially exhausted, used to back-up a vacuum brake system, particularly in the event of failure of the engine operated system.

4. Design Requirements

4.1 Maintenance of OEM Design Standards

Modifications should not introduce new single-point failures of the brake system which do not exist in the OEM system and which compromise user safety, including compromise or elimination of crashworthiness provisions provided by the vehicle manufacturer in conformance with FMVSS 105, 135, 106, 116, 201, 203 and 204, or the general provisions of FMVSS 201. In any areas where the modification and reinstallation of OEM components or the installation of additional components has the potential to affect the vehicles conformance with the listed FMVSS standards, the manufacturer should submit documentation as to why the modification does not affect performance or data showing that the performance of the modified system meets the standard. (APPENDIX RTP 3.1)

Rationale: It is recognized that single-point failure modes exist in the OEM configuration of brake systems. The intent of this paragraph is to not compromise the inherent reliability of the original equipment configuration by introducing more single point failures.

4.2 Conventional Use of Motor Vehicle

All power brake conversions to which this standard is applicable should be designed to permit the use of the brake pedal by able-bodied drivers. (APPENDIX RTP 3.2)

Rationale: It is occasionally necessary for someone other than a disabled owner to operate a vehicle (family, maintenance personnel etc.) Although the level of effort is considerably less the conversion should not require operator inputs in directions of movement other than that found in the OEM system. Having these individuals operate a vehicle with controls with which they are not familiar and may not have had training is to be avoided.

4.3 Mandatory Backup for Reduced Effort Braking

All reduced effort braking modifications should incorporate into the modification a backup capability in case of primary power failure. The backup system should be activated automatically in case of engine failure. The backup source of braking energy should be isolated from the primary source through a check valve or other appropriate means of assuring that a primary system failure will not cause a failure of the backup system. (APPENDIX RTP 3.3)

Rationale: The purpose of this requirement is to provide the disabled driver some of the same protection from failure available to a non-disabled driver with the original brake system. The able-bodied driver can retain a measure of braking capability in the event of loss of power boost. A disabled driver will not have this capability, since the modification covered herein is configured to adapt to his inability to use the original equipment powered system.

4.4 Energy for Reduced Effort Braking Backup Systems

4.4.1 The energy source for the Reduced Effort Braking Backup System should incorporate a vacuum tank. An auxiliary electric driven pump may be used in addition to, but not in place of, a vacuum tank. (APPENDIX RTP 3.4)

- 4.4.2 The primary power for the backup brake system should be engine vacuum but the system should operate when the engine is not running. (APPENDIX RTP 4.1.3)

4.5 Reduced Effort Braking Performance

The force needed to apply the brakes should be measured according to the applicable procedures of SAE J299, "Inservice Brake Performance Test Procedure Passenger Car and Light Duty Truck", and specifically paragraphs 1, 2, 3, 4, 5, 6.1, 7.1 (except 7.1.9), 7.2, 7.4, 7.5, and 7.6.

4.5.1 REDUCED PEDAL EFFORT

Failure of the modified power brake system to attain the deceleration or stopping distances attainable with the (OEM) power brake with 30% less pedal force at both maximum deceleration and at 0.3 g deceleration should be grounds for rejection of the modification. (APPENDIX RTP 4.1.1)

Rationale: This performance test ascertains that, at a minimum, the modification in no way degrades the performance attainable with the unmodified power brake system. In fact, there should be a 20% reduction in force required to operate the brakes to specified levels of deceleration.

4.5.2 OPERATION AT HIGH ALTITUDE

A label should be installed on the instrument panel of all vehicles modified with reduced effort brakes which states "THE REDUCED EFFORT BRAKES ON THIS VEHICLE WERE DESIGNED FOR USE BELOW XX,000 FEET ALTITUDE". The altitude should be determined by the manufacturer for his/her product and inserted in the space indicated. (APPENDIX RTP 3.9.2)

Rationale: Modified boosters may suffer braking degradation at high altitudes where the pressure differential between engine vacuum and atmospheric pressure is reduced. Some vehicles may require brake boosters which are larger than OEM boosters to retain adequate reduced effort braking. This will assure that the necessary changes in brake boosters have been made if needed or the user will know that the vehicle is not suitable for use at high altitudes.

4.6 Pedal Reserve

The pedal reserve in the vehicle in which reduced effort braking and/or reduced effort braking backup system has been installed should be no less than in the vehicle with standard (OEM) power brakes. (APPENDIX RTP 4.1.2)

Rationale: The modifications should not compromise the braking system after normal wear on the brakes has occurred by causing the brake pedal to be any closer to the floor than in a vehicle with standard brakes

4.7 Operational Test

The combined reduced effort braking and reduced effort braking backup system should withstand 70,000 cycles of bench test operation with no degradation in braking performance in stopping distance (as measured by brake line pressure), pedal pressure, pedal reserve or noticeable wear, fraying or other anomalous conditions not present at the commencement of testing. (APPENDIX RTP 4.2.6)

Rationale: Fifty thousand cycles should bring out any system design problems which arise in use but not necessarily due to wear.

4.8 Backup Vacuum Reserve

The reduced effort braking backup system should provide sufficient backup for a minimum of ten stops using the backup system alone. Braking performance should be equal to that provided with the normal vacuum source connected. Five of these stops should not require a force at the pedal in excess of that under primary power. Five more stops should be made at the end of which brake effort should not exceed twice the level of effort required for primary brake system actuation to achieve the same deceleration. (APPENDIX RTP 4.2.1)

Rationale: A disabled driver may be totally dependent upon the backup system to get their vehicle off the road and bring it to a full stop. A vacuum sufficient for five full stops with no degradation of performance and five stops with maximal effort on the part of the operator is needed

4.9 Vacuum Maintenance Capability

4.9.1 The vacuum tank and lines of the reduced effort braking backup system should be sealed tightly enough such that when the system is not in use, the vacuum should not drop below 50% of normal working level within 4 h. (APPENDIX RTP 4.2.2)

4.9.2 The vendor should certify that the vacuum tank wall thickness used meets ASTM standards for the vacuum and conditions encountered. (APPENDIX RTP 2.7)

Rationale: This bench test establishes the tightness of the system. Experience has shown that even a vacuum control system for automotive heating and air conditioning controls can retain usable vacuum for 24 h when properly sealed.

4.10 Mandatory Automatic Actuation of Backup Systems

4.10.1 VACUUM TANKS

If the vacuum tank is not directly connected to the brake booster, actuation must be tested. Normally, reduced effort braking backup systems which use a vacuum tank are connected directly to the braking booster. If this is the case, the backup is 'always there' and is instantaneous. (APPENDIX RTP 4.2.3.1)

4.10.2 MOTOR DRIVEN VACUUM PUMPS

Systems which use a backup electric motor-driven vacuum pump as a part of the reduced effort braking backup system should cause actuation of the backup pump at, or prior to, the time when the vacuum level falls to a point that would cause the pedal pressure to double in order to produce the hydraulic brake line pressure needed to produce the threshold of wheel lockup for maximum brake application. The vacuum pump should subsequently raise the vacuum to normal operating levels. (APPENDIX RTP 4.2.3.2)

4.10.3 CHECK VALVE

A check valve or equivalent device should be used to isolate the Vacuum Tank from the pump or the OEM brake booster. (APPENDIX RTP 3.3)

Rationale: If there is a problem with the brakes, the driver may be far too preoccupied to actuate a backup pump manually. The automatic actuation will provide for continuing brake service. The check valve would reduce the possibility of the Vacuum bleeding back through the Vacuum Pump.

5. Materials and Components

5.1 Reduced Effort Power Brake Boosters

Power brake boosters which are modified and/or installed as part of a reduced effort power brake system or a reduced effort power brake backup system should be the OEM power brake booster for that vehicle or a substitute with equal or better performance. (APPENDIX RTP 2.6)

Rationale: It has been found that there are some non-OEM brake boosters available in the aftermarket area and that the use of OEM boosters from other brands of vehicles may not always work properly in this application.

5.2 Electrical Components and Wiring

5.2.1 APPLICABLE STANDARDS

Electrical components and wiring should conform to the Society of Automotive Engineers Standards or Recommended Practices as applicable. Those listed below are applicable to the wiring of the electrical control system for the reduced effort braking system warnings and powered backup system. (APPENDIX RTP 3.5.1)

SAE J258, SAE J553 (JUN88): Circuit Breakers

SAE J1292 (OCT81): Automobile Wiring

SAE J561 (JUN80), SAE J858a, SAE J928 (JUN80): Electrical Terminals

Rationale: It is expected that all equipment designed to an SAE Standard or Recommended Practice meets other applicable SAE Standards or Recommended Practices.

5.2.2 PACKAGING OF ELECTRICAL SYSTEMS

All electrical systems should be designed and packaged to protect the driver or passengers against injury resulting from short circuits, electrical fires and similar accidents. (APPENDIX RTP 3.7)

Rationale: The electrical systems have the potential to cause injury in a number of ways. Design consideration must be given to the prevention of such injuries.

5.2.3 PROTECTION FROM WEATHER

Electrical components which are exposed to the environment outside the enclosed portions of the vehicle should be protected from failure due to weather and the conditions noted in SAE standard J1211 for environmental practices should be considered. (APPENDIX RTP 3.8).

Rationale: Some of the electrical components of a reduced effort braking backup system may be exposed to the weather. They should be protected appropriately. It is expected that all equipment designed to an SAE Standard or Recommended Practice meets other applicable SAE Standards or Recommended Practices.

5.3 Protection of Hoses

Vacuum hoses should be protected from rubbing on any components or bearing on exhaust system components. (APPENDIX RTP 3.6)

Rationale: One frequent cause of vacuum hose failure is improper contact with other vehicle components.

5.4 Vacuum Fittings and Hoses

All vacuum fittings and hoses should conform to the Society of Automotive Engineers Standards or Recommended Practices as applicable. (APPENDIX RTP 3.5.2)

SAE J536B—Hose Clamps
SAE J1403 - JUN 85—Vacuum Brake Hose
SAE HS 24—Motor Vehicle Braking Systems and Components

5.5 Fasteners

5.5.1 APPLICABLE STANDARDS

All fasteners used should conform to the Society of Automotive Engineers Standards or Recommended Practice or ANSI Standards as applicable. (APPENDIX RTP 3.5.3)

ANSI/ASME/B 18.21—Lock Washers (Supersedes SAE J489)
ANSI/ASME/B 18.2.2—Square and Hex Nuts (Supersedes SAE J104)
ANSI/B 18.2.1—Hex Bolts
ANSI/B 18.6.1—Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.2—Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.3—Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.4—Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.22.1—Plain Washers (Supersedes SAE J488)
ANSI/B 18.6.3—Square and Hex Nuts (Supersedes SAE J104)
SAE J58—Flanged 12-Point Screws
SAE J78—Steel Self-Drilling Tapping Screws
SAE J81—Thread Rolling Screws
SAE J82—Mechanical and Quality Requirements of Machine Screws
SAE J238—Nut and Conical Spring Washer Assemblies
SAE J102—Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J103—Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J104—Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J105—Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J122a—Surface Discontinuities on Nuts
SAE J123—Surface Discontinuities on Bolts, Screws, and Studs in Fatigue Applications
SAE J174—Torque-Tension Test Procedure for Steel Threaded Fasteners
SAE J238—Nut and Conical Spring Washer Assemblies
SAE J474a—Screw Threads
SAE J482—Hexagon High Nuts
SAE J483—Crown (Blind, Acorn) Nuts