

	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J2604	ISSUED OCT2007
		Issued 2007-10	
Recommended Test Procedure for Powered Gas Brake Control Systems			

RATIONALE

Not applicable.

1. SCOPE

This test procedure is for qualification testing of powered gas/brake control systems to assure compliance with the Recommended Practices for these assistive devices. A powered gas/brake control system which passes all of the tests shall be considered to be in compliance with the Recommended Practices. The control shall pass all tests denoted by a "shall" in the Recommended Practice or the Recommended Test Procedure. All the results of all tests and requirements denoted by a "should" shall be noted, but failure to comply will not constitute failure to pass the test.

1.1 Testing Protocol

Two production samples of the powered gas/brake control system and a documentation package shall be submitted to the testing facility designated to perform the testing. The test facility will be designated by the manufacturer.

1.1.1 Installed System

A complete installed system shall be available for continuous use during the course of testing. The vehicle shall have the complete installation of the powered gas/brake control system as it would be delivered to the user including all labeling and manuals.

1.1.2 Uninstalled System

A complete uninstalled system shall be supplied for bench testing and study of individual components. All parts of the original equipment system which are modified in any way, and all additional parts that make up the powered gas/brake control system installation (labels, gauges, hoses etc.) shall be supplied.

2. REFERENCES

2.1 Applicable Publications

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

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2.1.1 SAE Publications

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 J2603 Powered Gas/Brake Control Systems

2.1.2 FMVSS Publications

Available from the Superintendent of Documents, U.S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

FMVSS 124 Accelerator Control Systems (CFR V 571.124)

FMVSS 135 Passenger Car Brake Systems (CFR V 571.135)

3. RECEIVING INSPECTION

Inspect the unassembled system to determine that the following items have been provided and meet the referenced Recommended Practices. The inspections should be documented on an appropriate report form with photocopies or photographs as required.

3.1 Packaging

Inspect the shipping packages and all parts of the powered gas/brake control system inside the packaging for compliance with Recommended Practice SAE J2603 Section 4.19.

3.2 Powered Gas/Brake Control System Users Manual

Inspect the manual for compliance according to the following table by referring to Recommended Practice SAE J2603.

<u>Item of Inspection</u>	<u>Recommended Practice Paragraph</u>	<u>Special Considerations</u>
Control Description	6.5.1	
User Operation	6.5.2	
Recommended Maintenance	6.5.3	
Special Purpose Tools	6.5.3	
Manufacturer Address	6.5.4	
Caution to Check Brakes	6.5.5	
Shift to Neutral and Turn Off Engine	6.5.6	
Warranty Information	6.5.7	

3.3 Powered Gas/Brake Control System Installation Manual

Inspect the manual for compliance according to the following table by referring to SAE J2603.

<u>Item of Inspection</u>	<u>Recommended Practice Paragraph</u>	<u>Special Considerations</u>
EMI Provisions	4.9	
Furnished Peripheral Components	6.5	Do in conjunction with Parts List (below)
Modified OEM Parts	6.6	Do in conjunction with Parts List (below)
Warning Label	6.4	If not on gas/brake control
Vehicle Applicability	7.1	
Fluid Schematic Flow Diagrams	7.2	
Electrical Diagrams	7.3	
Parts List	7.4	Do in conjunction with Furnished Components and OEM Parts (above)
Maintainability	7.5	
No Operator Adjustments	7.6.1	
Components Attached to Control Box	7.6.2	

<u>Item of Inspection</u>	<u>Recommended Practice Paragraph</u>	<u>Special Considerations</u>
Labels	7.6.3	
Lockout	7.6.4.1	
Interlocks	7.6.4.2	
Dynamics Considerations	7.6.5	
User Information	7.6.6	
Means of Shifting to Neutral Turning Off the Engine/Motor	7.6.7	

3.4 Furnished Components

Determine whether all parts identified in the Installation Manual parts list and special purpose tools for user maintenance, are in fact furnished by the manufacturer by inspection of the unassembled system. Note the absence of any items required for assembly and installation. Notify the manufacturer immediately of any discrepancies before attempting assembly or installation. (SAE J2603 Section 4.15.2, SAE J2603 Section 5.5)

3.5 Modified OEM Parts

As part of the Furnished Components Inspection of paragraph 3.4, determine that any OEM parts or other purchased components which have been modified and are included in the installation parts kit have permanent warning labels or other markings on the part (or assembly of parts) indicating that they have been modified and shall not be replaced with OEM parts. (SAE J2603 Section 5.6)

3.6 Other Documentation

Inspect other documentation included with the unassembled system for compliance according to the following table by referring to Recommended Practice SAE J2603.

<u>Item of Inspection</u>	<u>Recommended Practice Paragraph</u>	<u>Special Considerations</u>
Input Force Requirements	4.1.1	
Failure Analysis	4.1	
Components Selected for Backup	4.1	
Identification of Components	4.4.1	
Means to Disconnect Components	4.2.4.2	
EMI Interference	4.9	
Torque Specifications for All Mounting Fasteners	4.4.2	
Static Load for Full Brake	6.1.4.2.1	
Static Load for Full Accelerator	6.1.4.2.2	
Recall Plan	8.2	
NHTSA Registration	8.3	

3.7 Identification Marking

Inspect every major assembly of the powered gas/brake control system for permanent markings with the manufacturer's name, trademark, or other recognizable logo. Such marks shall be on the exterior of the product. These marks shall include parts numbers keyed to parts lists and/or diagrams. At least one major component of the powered gas/brake assembly shall have the serial number of the system where it can be seen without disassembly. (SAE J2603 Section 8.1)

4. VISUAL AND TACTILE INSPECTION OF THE INSTALLED SYSTEM

Inspect the installed system and the vehicle in which it is installed to ensure that the system meets the requirements of SAE J2603, according the following table by referring to Recommended Practice SAE J2603. The inspections should be documented on an appropriate report form with photocopies or photographs as required. The report should follow the format of the Test Procedure (including order and paragraph numbering).

<u>Item of Inspection</u>	<u>Recommended Practice Paragraph</u>	<u>Special Considerations</u>
Control Box Components	4.25.1	
Sufficient Slack	4.25.2	
Positive Attachment	4.25.3	
Chafe Protection	4.25.4	
Vehicle Interface	4.24	
Attachment	4.22	
Effect on Performance	4.11	
Clearances for Maintenance	4.21	
Compatibility with Drivers without a Disability	4.12	
Injurious Exposures	4.13	
Operator Safety	4.14	
Cleanliness	4.20	
Driver Vision	4.21	
Maintainability	4.15.1	
Maintenance	4.15.3	
Accommodation for Wear	4.16	
Environmental Resistance	4.17	
Mechanical Finish	4.8	
Shift to Neutral and Turn Off Engine	4.5	
Inadvertent Operation	4.5.2	
Protection of Hoses and Tubing	5.2	
Fasteners	5.4.1	Structural Fasteners
Warning Label	6.4	
Control Shutoff Operation	6.6	
Control Shutoff Location	6.6.1	
Control Shutoff Interlock	6.6.2	
Control Shutoff Override	6.6.3	
Labels	6.8	
Identification Markings	8.1	

5. PERFORMANCE TESTS

The following tests call for certain detailed test procedures to assure conformance with the associated Recommended Practice J2603 for powered gas/brake control systems.

5.1 Vehicle Tests

5.1.1 Braking Performance Test

The following test procedures will be used to determine that the powered gas/brake control system does not degrade the braking performance of a fully functional OEM braking system and can function effectively with a degraded OEM braking system. They shall be conducted using the road surface conditions stipulated in Federal Motor Vehicle Safety Standards 135, Sections 6.1 (Ambient Conditions) and Section 6.2 (Road Test Surface).

- 5.1.1.1 The first test calls for a comparison of performance between using a powered gas/brake control system and not using that modification on the same vehicle. The tests comparing the OEM and the modified system should be completed "back to back" or within 24 hours of each other. The test vehicle shall have an ABS braking system.
 - a. The vehicle shall be accelerated to 48 Kilometers per hours (30 miles per hour) and maintained at that speed while approaching a cone on the ground (speedometer accuracy is sufficient).
 - b. As the driver passes the cone the driver shall activate the brakes in such a manner as to stop the vehicle as quickly as possible including initiation of ABS.
 - c. The distance from the cone to the point on the ground below the center of front wheel of the stopped vehicle shall be measured.

- d. This test shall be repeated 10 times using the powered gas/brake control system and 10 times using the OEM brake pedal (without using the powered gas/brake control system. Each stop shall be done no sooner than 5 minutes after the previous stop.
- e. The mean and the standard deviation of the group of 10 stops for each configuration shall be calculated.
- f. If any of the 10 stopping distances for either configuration (using the powered gas/brake control or using the OEM brake pedal) varies by $\pm$ three feet from the mean of the stopping distances for that configuration, the set of 10 stops shall be repeated for that configuration.
- g. The mean of the stopping distances using the powered gas/brake control shall not be over one standard deviation (of the OEM data) greater than the mean of the stopping distances for the vehicle using the OEM brake pedal. (See notes at end of document for definitions of mean and standard deviation.) (SAE J2603 Section 4.1)
- h. After the 10th run in a successful series in "d" above (success being determined in "f" above) an 11th run shall be made. The force and distance traveled by the control handle for a stop equivalent to the OEM (as determined by "g" above) shall not exceed the forces and distances supplied by the control manufacturer (SAE J2603 4.1.1). A force measuring device may be needed to measure the force on the control handle.
(Note to tester: The tests using the powered gas/brake control and not using the OEM brake pedal shall be done as close together in time and vehicle mileage as possible and shall use the same tires, roadway, brake system components, approximate wind conditions, etc.)

NOTE: For use in 5.1.1.1 above, the mean and standard deviation are defined as follows. The mean for a set of trials is the sum of all of the stopping distances in the 10 trials, divided by the number of trials (10). The standard deviation for a set of trials is the square root of the value found when the mean for each trial is subtracted from each of the stopping distances in that trial, that difference is squared, all of the squared values are added together and that total is divided by the number of trials (10).

5.1.1.2 With the engine off, the brake line(s) associated with the operation of the front brakes (or either line if it is a diagonal brake backup system in the OEM master cylinder) shall be removed. A force measuring device under the brake pedal shall be used to measure the force exerted at the brake pedal pad by the powered control system actuator at the end of the pedal travel. The powered gas/brake control brakes shall be applied and a load equivalent to a minimum of 500 N (112.4 pounds) on the brake pedal pad shall be measured, regardless of where the force is actually applied by the gas/brake control. (SAE J2603 Section 4.1.2)

5.1.2 Limitation on Maximum Output

5.1.2.1 In a stationary vehicle, with the engine off and the connection from the gas pedal to the OEM accelerator control system replaced by a force measuring device) the control lever shall be moved to the maximum movement for the gas control motion. The output force to the accelerator pedal, as measured by a transducer mounted between the control actuator and the pedal shall not exceed 222 N (50 pounds). (SAE J2603 Section 4.8)

5.1.2.2 In a stationary vehicle, with the engine on, the control lever shall be moved to the maximum movement for the brake and the output force to the OEM brake system noted. This shall be done in the partial brake failure mode described in FMVSS 135 (S 7.11). The maximum force output of the powered gas/brake control to the OEM pedal as measured by a transducer mounted between the control actuator and the brake shall not exceed 1330 N (300 pounds). (SAE J2603 Section 4.8)

5.1.3 Primary Backup System

The tester shall identify the components being backed up per SAE J2603 Section 5.2.4.1 (See RTP 3.6). The tester shall install (or have the manufacturer install) the means to disconnect the components being backed up on the test vehicle per SAE J2603 Section 4.2.4.2 (See RTP 3.6).

5.1.3.1 Automatic Activation of Primary Backup for Brakes

The control system components being backed up (as determined by the failure analysis submitted in 3.6 above) shall be disconnected. The vehicle shall be accelerated to 48 Kilometers per hours (30 miles per hour) (speedometer accuracy is sufficient) and maintained at that speed for 10 seconds. The brakes shall then be applied on the powered control using the backup system provided to stop the vehicle.

5.1.3.1.1 The primary backup braking performance test of RTP 5.1.1.1 shall be repeated three times (as opposed to 10 times) (this test may be done at the same time as RTP 5.1.1.1. The braking shall pass the test with the same criteria as for the fully functional powered gas/brake control (within one standard deviation of the mean of the stopping distance achieved by the same vehicle using the OEM pedals). (SAE J2603 Section 4.2.2)

5.1.3.1.2 It should be noted that successfully completing the conditions of RTP 5.1.1.1 in 5.1.3.1.1 above automatically meets the condition of providing backup for at least 5 minutes. (SAE J2603 Section 4.2.3)

5.1.3.1.3 The operator shall not need to remove their hand from the control for automatic action of the backup brakes to occur. (SAE J2603 Section 5.3)

5.1.3.1.4 The operator shall demonstrate the capability of shifting to neutral and switching off the engine/motor with the backup system allowing the powered brake control to remain functional. (SAE J2603 Section 4.5.1)

5.1.3.2 Automatic Activation of Backup for Gas Control (if furnished)

a. The vehicle shall be accelerated to 80 Kilometers per hours (50 miles per hour) (speedometer accuracy is sufficient) and maintained at that speed for 10 seconds.

b. The control system components being backed up shall be disconnected with the Gas still applied on the powered control. That speed shall be maintained for 2 minutes, then the vehicle shall be decelerated within 30 seconds to 30 Kilometers per hours (18 miles per hour), remain at that speed for 30 seconds, then accelerate back to 80 Kilometers per hours (50 miles per hour) within another minute. The vehicle shall maintain that speed for the remainder of 5 minutes from the time the components were disconnected. (SAE J2603 Section 4.2.3)

5.1.4 Automatic Actuation of Emergency Backup Brake System

The manufacturer shall furnish to the tester the following information:

- Identification of the primary brake actuator for the powered gas/brake control.
- A means for disconnecting the primary brake actuator from the control system, in such a way that the remainder of the control system remains functional and no harm is done to either the OEM vehicle or the control system when the actuator is disconnected.

The tester shall disconnect (or have the manufacturer disconnect) the primary brake actuator on the test vehicle.

5.1.4.1 The vehicle shall be accelerated to 48 Kilometers per hours (30 miles per hour) (speedometer accuracy is sufficient) and the brakes applied using the powered gas/brake control handle. The vehicle shall come to a full stop within 15 seconds. (SAE J2603 Section 4.4)

5.1.4.2 The tester shall note that in applying the brakes, even if full excursion of the control lever is needed, the operator shall not need to remove their hand from the control for automatic action of the backup brakes to occur. (SAE J2603 Section 4.4)

5.1.5 The tester shall drive the vehicle to determine subjectively whether the handling characteristics of the vehicle have been degraded by the location, weight or positioning of the powered gas/brake control system. (SAE J2603 Section 4.13)

5.1.6 The tester shall drive the vehicle to observe that the operator can not make any adjustments to the system (other than control inputs) while the vehicle is in motion. (SAE J2603 Section 6.2)

5.1.7 Automatic Backup Activation Warning

The test shall be accomplished by disconnecting the primary power to the installed system.

5.1.7.1 Visual Indicator

When the primary system power (vacuum, hydraulic etc.) is disconnected and the backup system power is activated, a visual indicator shall activate. The indicator shall be yellow amber or red, it shall be installed as indicated in the installation manual or on the control box supplied with the powered control system, it shall flash at 2 Hz, 50/50 on-off, and shall be labeled "POWERED GAS BRAKE BACKUP ON". The label shall conform to SAE J2603 Section 7.6.3. If installed on a location other than the gas/brake control box, the warning indicator shall be installed at or up to 15° below a horizontal plane that intersects the bottom of the internal rear view mirror. (SAE J2603 Section 6.7.1)

5.1.7.2 Auditory Indicator

An auditory Indicator should be used in addition to the visual indicator, but the visual indicator is required. When the primary system power (vacuum, hydraulic etc.) is disconnected and the backup system power is activated, a auditory indicator should activate. The tester shall determine that the auditory indicator is at least 6 dB as measured over an 80 dB white noise environment.

NOTE: The auditory indicator is optional. (SAE J2603 Section 6.7.2)

5.1.8 Install a data acquisition system to capture brake line pressure on a moving vehicle. This test is used to determine the brake line pressure required to activate the ABS on a dry concrete surface at 48 Kilometers per hour (30 miles per hour). The test shall be conducted to gather data for RTP 2.1.1.

5.2 Bench Tests

The control assembly and the output mechanisms shall be mounted into a suitable cyclic loading machine or machines in such a manner that its intended actuating movements, linear, rotational, or both as called for in the tests described below can be performed by the test machine. The test facility shall provide system power (electrical, vacuum, hydraulic pressure etc.) at the nominal operating levels specified by the manufacturer as representative of the vehicles for which the control is intended. The spring tension (resistance) of the brake and accelerator pedals shall be as follows. The brake pedal shall have a spring tension (resistance) of 8.9 kg/cm (50 pounds/inch) for the first 5.1 cm (2 inches) of travel and 53 kg/cm (300 pounds/inch) thereafter. The accelerator pedal shall have a spring tension (resistance) of 1.8 kg/cm (10 pounds/inch). All combined functions (for example, gas and brake) shall be loaded in one contiguous test series, alternating from one function to the other. The test load shall be applied through an appropriate fixture to the control handle in the direction of application specified in the operating instructions.

5.2.1 Control Predictability

All of the Control Predictability tests should be conducted on the installed unit or bench tests.

5.2.1.1 Repeatability

Static displacements (loads, if the system requires a force input rather than a position input) corresponding to 25%, 50%, and 100% brake system actuation shall be applied to the brake control handle for a period of 30 seconds. This test should, be done in conjunction with the Constant Input/Constant Output test in 5.2.1.2 below. The criterion for 100% brake system actuation in this test is the brake line pressure required to lock the brakes (or activate the ABS) on dry concrete surface at 48 Kilometers per hour (30 miles per hour). This data was obtained in RTP 5.1.8 above. Similar displacement loads shall be placed on the gas control handle so as to produce 25%, 50% and 100% of gas pedal displacement. (100% gas pedal displacement will be defined as the position of the gas/brake control handle when the OEM gas pedal is fully depressed when using the gas/brake control system. The loads to the control handle shall be applied 10 times with at least 10 seconds between loads. The movement of the output (or the output load) shall be measured. A given input displacement (load) to the control handle on the powered gas/brake control shall cause a specific repeated corresponding output displacement (load) from the powered gas/brake control to the OEM brake or gas pedal with variability of less than $\pm 5\%$. (SAE J2603 Section 6.1.1).

5.2.1.2 Constant Input/Constant Output

The static displacements described in 5.2.1.1 above shall each be applied to the control handle and held constant for a period of 30 seconds. This test should, be done in conjunction with the Repeatability test in 5.2.1.1 above. The displacements of the control handle shall be applied 10 times with at least 10 seconds between loads. The movement of the output (or the output load) shall be measured. A constant input displacement (load) to the control handle on the powered gas/brake control shall result in a constant output displacement (load) to the OEM system with variability of less than or equal to ± 3 mm deviation from the average for each cycle. (SAE J2603 Section 6.1.2)

5.2.1.3 Reaction Time to Control Input

The displacements described in 5.2.1.1 above shall each be applied to the control handle as quickly as possible (nominally a step input). The control inputs for gas and brake shall be measured independently and be within the travel of the gas or brake (In other words, the control shall be moved from null to some specified input, not from some level of brake control input to some level of gas input). The displacements of the control handle shall be applied 10 times with at least 10 seconds between loads. The displacements of both the input to the powered gas/brake control and the OEM controls shall be recorded and plotted versus time (do not depend upon a stopwatch). The delay between the time when the input reaches steady state and the time when the output of the powered gas/brake control system reaches 63% of the steady state value associated with the input (see 5.2.1.2) shall be no more than 0.1 seconds.

NOTE: This test should be conducted at the same time as 5.2.1.1. (SAE J2603 Section 6.1.3)

5.2.1.4 Full Gas to Full Brake Response Time

A load with a constant spring constant shall be applied to the output of both the brake and gas actuators.

- a. A static unidirectional load, specified by the control manufacturer (See RTP 3.6) as representing the full application of brakes, shall be applied to the control handle in the direction of operation of the brake and held for 5 seconds.
- b. Within 1/10 (0.1) second a similar load, specified by the control manufacturer as representing full travel of the gas pedal (See RTP 3.6), shall be placed on the control handle in the direction of the gas control and held for 10 seconds.
- c. The loads to the control handle shall be applied 10 times with at least 10 seconds between loads.
- d. The same series of tests shall then be repeated with the change of control movement in the opposite direction.
- e. The time from the initiation of movement from the input to one control until completion of movement of the output of the other control shall be measured mechanically or electrically (do not depend upon a stopwatch).
- f. The movement of the output (or the output load) shall be measured in such a way that it can be related to the time elapsed from the initiation of a control movement.
- g. The powered gas/brake reaction time to a change in control input from full gas to full brake and from full brake to full gas shall not exceed 4/10 (0.4) seconds. (SAE J2603 Section 6.1.4.1)

5.2.2 Control Output Return to Null Position

The control system shall be mounted in the test device such that a unidirectional load can be applied to the control handle of the powered gas/brake system in the direction of the brake and in the direction of the gas pedal motion. The test device shall be set up to move the control handle to four positions 25%, 50%, 75% and 100% of its travel with the engine off, but normal vehicle power supplied to the control system. The test device shall be set up to record the position of the control handle and the portion of the control system to which the actuator is attached (gas or brake) and to plot the position with respect to time. The test device shall be set up such that when the control handle is released the actuator(s) allow the gas or brake pedals to return to the idle (for accelerator) and no brake input (for brakes) positions.