



SURFACE VEHICLE RECOMMENDED PRACTICE

J2690™

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Superseding J2690 OCT2016

Driveline Parking Brake Test Procedure for Medium Duty Vehicles

RATIONALE

SAE J2690 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This SAE Recommended Practice establishes uniform test procedures for friction based parking brake components used in conjunction with hydraulic service braked vehicles with a gross vehicle weight rating greater than 4500 kg (10 000 lb). The components covered in this document are the primary actuation and the foundation park brake. Various peripheral devices such as application dashboard switches or indicators are not included. These test procedures include the following:

a. Brake Related Tests

1. Brake Functional Performance
2. Brake Dynamic Torque Performance
3. Brake Corrosion Resistance
4. Brake Endurance with Torque
5. Brake Endurance without Torque
6. Vibration Resistance
7. Brake Ultimate Static Load
8. Brake Lining Wear Adjuster Function

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b. Actuation Related Tests

1. Mechanical Actuator Functional Performance
2. Mechanical Actuator Endurance
3. Mechanical Actuator Quick Release
4. Mechanical Actuator Ultimate Load
5. Spring Apply Actuator Functional Performance
6. Spring Apply Actuator Operating Temperature Range
7. Spring Apply Actuator Endurance
8. Spring Apply Actuator Corrosion Resistance
9. Spring Apply Actuator On-Off Switch
10. Spring Apply Actuator Vibration

1.1 Purpose

This document establishes uniform accelerated laboratory test procedures for evaluating comparative performance characteristics of driveline parking brake components. These tests are based upon long standing industry practices. The location of the driveline park brake on the vehicle is generally on the drive axle carrier or transmission assemblies.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publication

Available from SAE International, 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 J79 Brake Disc and Drum Thermocouple Installation

2.1.2 ASTM Publication

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 117-97 Standard Practice for Operating Salt Spray (Fog) Apparatus

3. DEFINITIONS

3.1 BRAKE ARM

The lever receiving input load from the actuation system. This lever is inside or attached to the driveline mounted brake. See Figure 1.

3.2 PARKING BRAKE LEVER

The lever in the truck cab that is used to apply and release the park brake. See Figure 1.

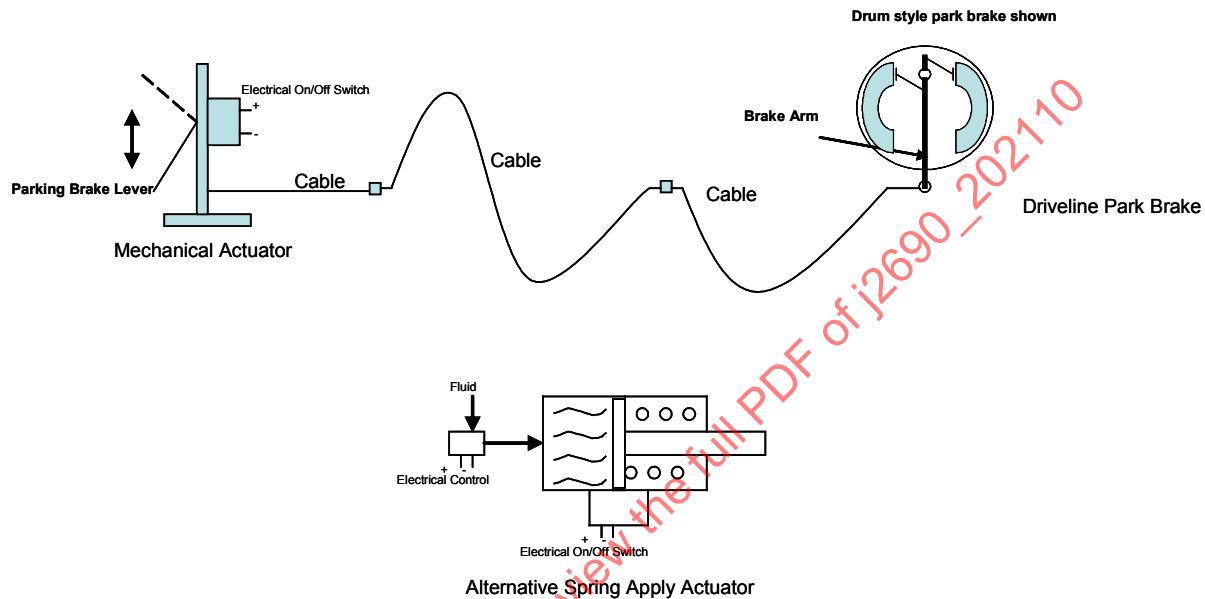


FIGURE 1 - PARK BRAKE SYSTEM DIAGRAM

3.3 ENDURANCE LIFE

The total number of applies and releases required for the endurance tests outlined herein. The endurance life requirement is dependent on vehicle vocation and usage and therefore will be as specified for the application for these tests. A suggested endurance life target is included herein.

4. GENERAL NOTES

4.1 Targets

It is important to note that a large range of reasonable test targets exist corresponding to the many and varied vehicle and parking brake customer usage patterns. Users of this specification should adjust the targets to suit their particular applications, particularly for the durability cycles presented in 5.4 and 5.5. The cycle requirements presented in these two sections are offered solely for the sake of having a tangible target, but represent what would be considered the low end of a range of possible test requirements for most medium and heavy truck and bus applications.

4.2 Temperature

Unless otherwise specified all testing shall be conducted at an ambient temperature of 15 to 32 °C (60 to 90 °F).

4.3 Mounting

All testing shall be conducted with the brake mounted essentially as intended on the vehicle and in accordance with the manufacturer's recommendations. The actual mounting position for each test shall be documented.

4.4 Cycle Rate (Endurance Test)

All endurance testing shall be done at a rate of up to 20 cycles per minute. Faster rates are permitted if no abnormal effects (vibration, temperature, noise) are introduced.

4.5 Test Conditions

Unless otherwise specified all tests will be conducted in the laboratory and with new components including friction materials and drum/rotor.

4.6 Brake Output Torque

Unless specified, the torque values are recorded at the desired brake input loads and in the static (no rotation) condition.

4.7 Brake Input Loads

Input loads to be determined based on the application. The load is measured at the brake arm, not the parking brake lever (generally located in the cab) or the spring actuator output (see Figure 1).

4.8 Direction of Applied Torque

Is designated as either clockwise or counter-clockwise as viewed from the front of the vehicle toward the rear.

4.9 Tolerance

4.9.1 Torque and force shall be $\pm 5\%$ unless otherwise specified.

4.9.2 Temperature shall be $\pm 3^\circ\text{C}$ (5°F).

4.10 Specific Monitoring of Loads and Travel

Due to actual vehicle or system set-up, it is not always practical to monitor all travel and loads at various locations. These locations and necessary system modifications must be tailored to the parking brake's intended application and noted accordingly.

4.11 Test Samples

Recommended quantity for test samples are shown in Table 1. Unless otherwise specified, it is not necessary to use the same brake assembly for more than one test section.

TABLE 1 - TEST SAMPLE RECOMMENDED QUANTITY FOR EACH TEST

SECTION	TEST	RECOMMENDED QUANTITY
	<i>Brake Related Tests</i>	
5.1	Brake Functional Performance	5
5.2	Brake Dynamic Torque Performance	2
5.3	Brake Corrosion Resistance	2
5.4	Brake Endurance with torque	3
5.5	Brake Endurance without torque	3
5.6	Vibration Resistance	2
5.7	Brake Ultimate Static Load	2
5.8	Brake Lining Wear Adjuster Function	5
	<i>Actuation Related Tests</i>	
6.1	Mechanical Actuator Functional Performance	5
6.2	Mechanical Actuator Endurance	3
6.3	Mechanical Actuator Quick Release	1
6.4	Mechanical Actuator Ultimate Load	2
6.5	Spring Apply Actuator Functional Performance	5
6.6	Spring Apply Actuator Operating Temperature Range	2
6.7	Spring Apply Actuator Endurance	2
6.8	Spring Apply Actuator Corrosion Test	2
6.9	Spring Apply Actuator On-Off switch	2
6.10	Spring Apply Actuator Vibration Test	2

5. BRAKE RELATED TESTS

5.1 Brake Functional Performance

5.1.1 Burnish brake linings per manufacturer's recommendations. For laboratory test purposes, burnishing may be done on a suitable dynamometer, with speed and inertia load as appropriate for the size, axle ratio, wheel diameter, and speed of vehicle under consideration.

NOTE: A specially instrumented and calibrated brake arm, or a load cell at the cable input connection to the brake arm, may be required to insure correct load into the brake.)

5.1.2 With a brake arm load maintaining system (accuracy $\pm 5\%$) as shown in Figure 2, apply and hold 22 kg (50 lb) brake input force to the brake lever with no torque applied to the brake drum or rotor.

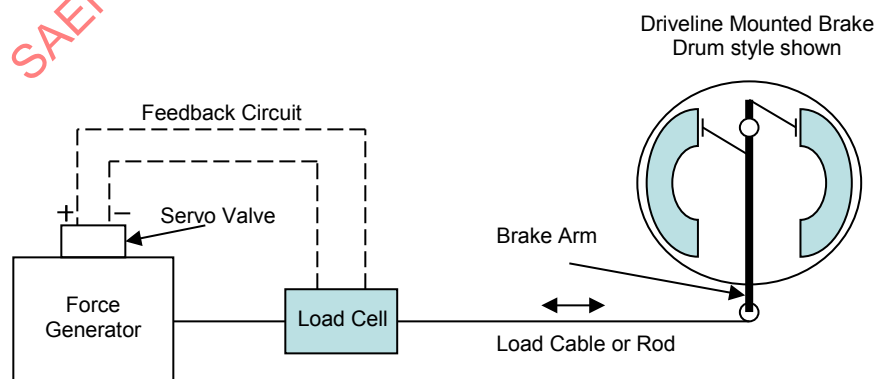


FIGURE 2 - BRAKE LEVER LOAD MAINTAINING SYSTEM

- 5.1.3 Apply 56 Nm (500 lb-in) torque to the drum in the clockwise direction (as would be installed facing rearward from the front of the vehicle). Increase torque at a rate of 113 to 1130 Nm (1000 to 30 000 lb-in) per minute.
- 5.1.4 Measure the maximum torque achieved before the drum or rotor assembly slides or slips. The slide or slip torque shall be defined as the maximum amount of torque achieved during the first 10 degrees of drum or rotor rotation.
- 5.1.5 Repeat above with torque applied in the opposite direction.
- 5.1.6 Repeat above with a brake lever load of 45 kg (100 lb) and up to the maximum parking brake lever load in increments of 23 kg (50 lb).
- 5.1.7 Record force and torque data.

5.2 Brake Dynamic Torque Performance

- 5.2.1 Install brake assembly on a dynamometer to allow the drum or rotor to rotate relative to the brake assembly. Verify clearance between brake and drum (cage clearance) or rotor is per manufacturer's recommendation. Install brake such that dynamometer rotational direction will be the same as forward direction of the vehicle.
- 5.2.2 Set dynamometer at appropriate dynamic inertia, or appropriate settings if not an inertia type dynamometer, based on vehicle parameters including weight, tire rolling radius, and axle ratio.
- 5.2.3 Install thermocouple in the drum or rotor in accordance with Recommended Practice SAE J79 or as agreed upon with the customer. Initial drum or rotor temperature shall be 93 °C (200 °F) or as otherwise agreed upon with the customer.
- 5.2.4 With a brake arm load maintaining system (accuracy $\pm 5\%$) as shown in Figure 2, burnish brake per manufacturer's recommendation. Record results including brake arm load and equivalent stop distance during the burnishing process.
- 5.2.5 At the desired dynamometer rotational speed, apply a 23 kg (50 lb) load to the brake arm. Apply time of the brake shall be less than 1.4 seconds after apply initiation.
- 5.2.6 Record revolutions to stop the inertia.
- 5.2.7 Repeat the above in increments of 50 lb brake arm load to the maximum input load desired.
- 5.2.8 Record brake arm force and equivalent distance to stop the inertia.

5.3 Brake Corrosion Resistance

- 5.3.1 Functional test each brake assembly and record the data
- 5.3.2 Position brake assembly and drum or rotor, or spring apply actuator, in an ASTM B 117 salt spray chamber or equivalent.
- 5.3.3 Orient components consistent with installation on the vehicle.
- 5.3.4 Subject components to 5% salt solution per ASTM B 117 for 100 h.
- 5.3.5 Remove brake assembly and drum or rotor from salt spray chamber and, within 1 h of removal, cycle the brake at 0 torque and brake arm input force per manufacturer for 100 cycles.

5.3.6 Continue to expose the same brake components for a total of 500 h exposure to the salt spray chamber, repeating the above cycling inspection and cycling in 100 h salt spray (fog) increments per 5.3.2 and 5.3.3. After the 500 h salt spray exposure is complete, within 1 h after removal from the corrosion chamber, apply the brake at maximum brake arm load for 48 h minimum, and then release the brake.

5.3.7 Re-test the functional performance of the brake assembly (reference 5.1).

5.4 Brake Endurance with Torque

5.4.1 Functional test each brake assembly and record the data.

5.4.2 Install brake assembly and drum or rotor, per manufacturer's recommendations, in a test fixture having the capability to control brake arm force and applied drum or rotor torque in each direction.

5.4.3 Applying the appropriate brake arm load as intended for the application, and torque to the drum or rotor as specified below, proceed to subject the brake to the following duty cycle:

- 100 000 applies/releases
- 10 000 in-lb torque each apply
- Alternate direction of torque every 5th apply.

NOTE 1: Other duty cycles or loading may be more appropriately suited for the brake's intended application. See also 4.1.

NOTE 2: During this test, new shoes and linings may be installed at 50 000 cycles or above.

NOTE 3: If other components loose functionality during the test, replace as necessary and document the change.

NOTE 4: The application components such as the apply cable are not subject to cycle life recommendations during this test due to the variability in routing of the cable and the cable life sensitivity to bend radii.

5.4.4 After the brake dynamic endurance test is complete, test the functional performance of the brake assembly and drum or rotor.

5.4.5 Visually inspect brake assembly and components.

5.5 Brake Endurance without Torque

5.5.1 Functional test each brake assembly and record the data.

5.5.2 Install brake assembly and drum or rotor, per manufacturer's recommendations, in a test fixture having the capability to control brake arm force. This test will not simulate torque.

5.5.3 Apply the appropriate brake arm load as intended for the application as specified below. Proceed to subject the brake to the following duty cycle:

- 500 000 applies/releases
- Loading – apply a load that would be required to obtain the torque outlined in 5.4.2

NOTE 1: Other duty cycles or load may be used as appropriate for the brake's intended application. See also 4.1.

NOTE 2: If other components lose functionality during the test, replace as necessary and document the change.

NOTE 3: The application components such as the apply cable are not subject to cycle life recommendations during this test due to the variability in routing of the cable and the cable life sensitivity to bend radii.

5.5.4 After the brake dynamic endurance test is complete, test the functional performance of the brake assembly.

5.5.5 Visually inspect brake assembly and components.

5.6 Vibration Resistance

5.6.1 Install brake assembly and drum or rotor on vibration machine in orientation consistent with the vehicle application.

5.6.2 For brakes mounted on the vehicle axle or transmission, with brake released, test assembly to the following vibration spectrum outlined in Table 2 for a minimum of 185 hours.

NOTE: This test spectrum may be different as agreed upon by the customer and supplier.

TABLE 2 - VIBRATION SPECTRUM

Frequency – Hz	Acceleration G rms ² / Hz
0	0
3	0.135
9	1.175
12	1.781
17	0.513
24	0.155
29	0.220
44	0.097
53	0.082
70	0.020

NOTE: Crest factor = 3.5 G rms

5.6.3 After completion of this test, test the functional performance of the brake assembly and drum or rotor.

5.7 Brake Ultimate Static Load

5.7.1 Install brake assembly and drum or rotor, per manufacturer's recommendations, in a test fixture having the capability to control brake arm force.

NOTE: A specially instrumented and calibrated brake arm, or a load cell at the cable input connection to the brake arm, will be required to measure this load.

5.7.2 With the brake assembly and drum or rotor positioned per manufacturer's recommendation, apply increasing brake arm load until the maximum rated load is achieved. Hold the maximum rated load for a minimum of 5 min.

5.7.3 Increase load to 4 times maximum rated load, or until the load can no longer be increased due to physical limitations of the brake, and hold for a minimum of 1 min.

5.7.4 Release load.

5.7.5 Record continuous test load including maximum load achieved.

5.8 Brake Lining Wear Adjuster

5.8.1 Orient brake assembly and drum or rotor per manufacturer's recommendation.

5.8.2 Adjust lining to drum or rotor clearance to $2 \times \pm 10\%$ manufacturer's nominal recommendation. Apply and release brake repeatedly until the wear adjuster no longer adjusts clearance.

5.8.3 If adjusting mechanism is dependent on torque or rotational displacement applied to the brake, apply torque or rotational displacement per the manufacturer's recommendation to accomplish the above.

5.8.4 Record final clearance or total lining clearance to rotor.

6. ACTUATION RELATED TESTS

6.1 Mechanical Actuator Functional Performance

6.1.1 Mount the actuator in accordance with the manufacturer's recommended procedure. See Figure 3 for typical arrangement. As part of the set-up, include a means to measure input force at the park brake lever or pedal, and output force of the actuator.

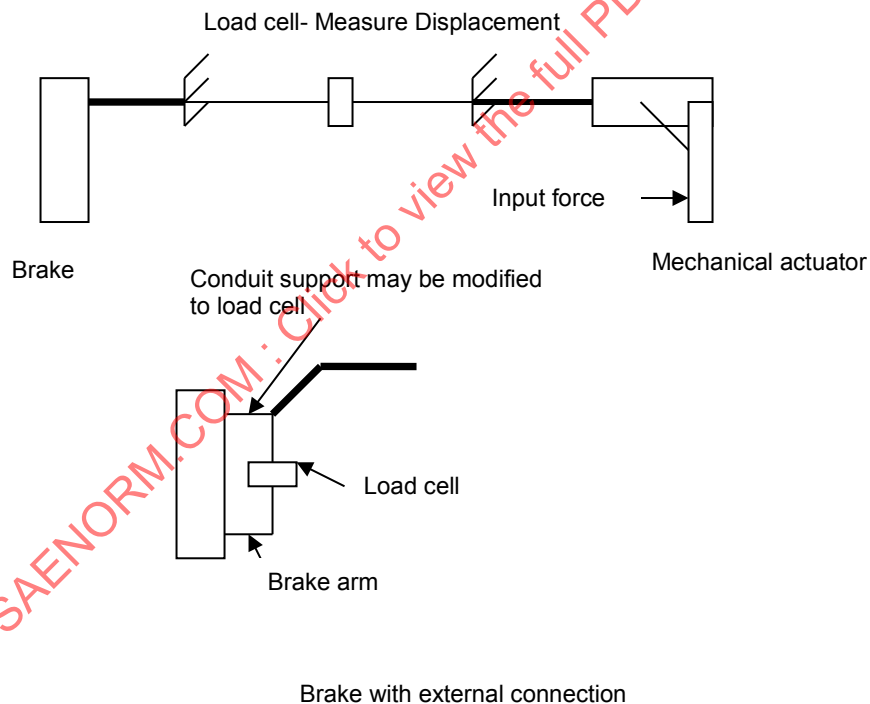


FIGURE 3 - MECHANICAL ACTUATOR TEST SET-UP

6.1.2 Adjust the actuator or system to produce the force as intended on the vehicle.

NOTE: A specially instrumented and calibrated brake arm, or a load cell at the cable input connection to the brake arm, can be used to insure correct load into the brake.

6.1.3 Apply the mechanical actuator while recording input, output force, and brake input load to desired load (or position if the actuator is an “over center” device). Apply rate shall be 0.5 to 2 s to full apply. This test shall be with 0 torque applied to the brake.

6.1.4 Release the mechanical actuator. Release rate shall be 0.5 to 2.0 s to full release. Record brake input load to verify free release (no brake drag). This test shall be with 0 torque applied to the brake.

6.1.5 Data shall be taken for graphical representation of all loads and travel.

6.2 Mechanical Actuator Endurance

6.2.1 With the same setup, stroke, loads, and apply and release rates, as per the 6.1 Functional Performance test above, apply and release the actuator the specified number of cycles to the desired level (reference 4.1).

6.2.2 Record actuator travel, input and output loads, and brake input loads at the beginning and end of the test.

6.3 Mechanical Actuator “Quick Release” (For “over center” type actuators only)

6.3.1 With the same setup, and apply rates, as per 6.1 Functional Performance test above, apply and then free release (uncontrolled rate) the actuator the total number of apply/release cycles per 5.4.3, or as appropriate to the brake's intended application.

6.3.2 Record actuator travel, input and output loads, and brake input loads at the beginning and end of test.

6.4 Mechanical Actuator Ultimate Load

6.4.1 Mount the actuator as intended on the vehicle, per the manufacturer's recommendation. Include a means to measure input load at the actuator handle or pedal, and output load.

NOTE: It is not necessary to have all cables and brake as in 6.1 Functional Performance test above.

6.4.2 Attach the output cable to a stationary point capable of withstanding the output load for this test.

6.4.3 Apply load to the handle (or pedal) until load can no longer increase due to malfunction or physical limitations within the brake actuator.

6.4.4 Record actuator input and output load data and note failure mode or limitation.

6.5 Spring Apply Actuator Functional Performance

6.5.1 Spring Apply Actuator Test Set-Up

Mount the spring apply actuator per manufacturer's recommendation. Actuator test set-up shall be equivalent to set-up on the vehicle application. Orientation, displacement, input pressure, and pull-rod resistive force shall be simulated as closely as possible to vehicle application. If necessary include cables, brake, drum or rotor, and other appropriate hardware as intended (routed and positioned) on the vehicle. As part of the set-up, include a means to measure continuous input pressure, output force, and displacement of the spring apply actuator. In practice a mechanical spring or pneumatic cylinder can be used for resistance as shown in Figure 4.