SAE International® SURFACE VEHICLE RECOMMENDED PRACTICE

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External Automatic Brake Adjuster Test Procedure - Truck and Bus

RATIONALE

Deletion of obsolete terminology (i.e. "slack"), and inclusion of other clerical or error corrections and additional comments or clarification where appropriate. Verification and confirmation of residual torque value in 6.3.2, 7.1.2, and 9.1.3, and total deflection rate value in 6.3.4, 7.1.4, and 9.1.5.

1. SCOPE

This SAE Recommended Practice is intended for testing of external automatic brake adjusters as they are used in service, emergency, or parking brake systems for on-highway vehicle applications.

1.1 Purpose

This document establishes an accelerated laboratory test procedure for external automatic brake adjusters to determine the integrity and durability in various functional modes and environmental conditions.

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 Publications

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 J726 Air Cleaner Test Code

SAE J786a Brake System Road Test Code - Truck, Bus, and Combination of Vehicles

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 C 150-56 Specification for Portland Cement

2.1.3 FMVSS Publication

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

FMVSS-121 Air Brake Systems—Tractors, Trucks, Buses and Trailers

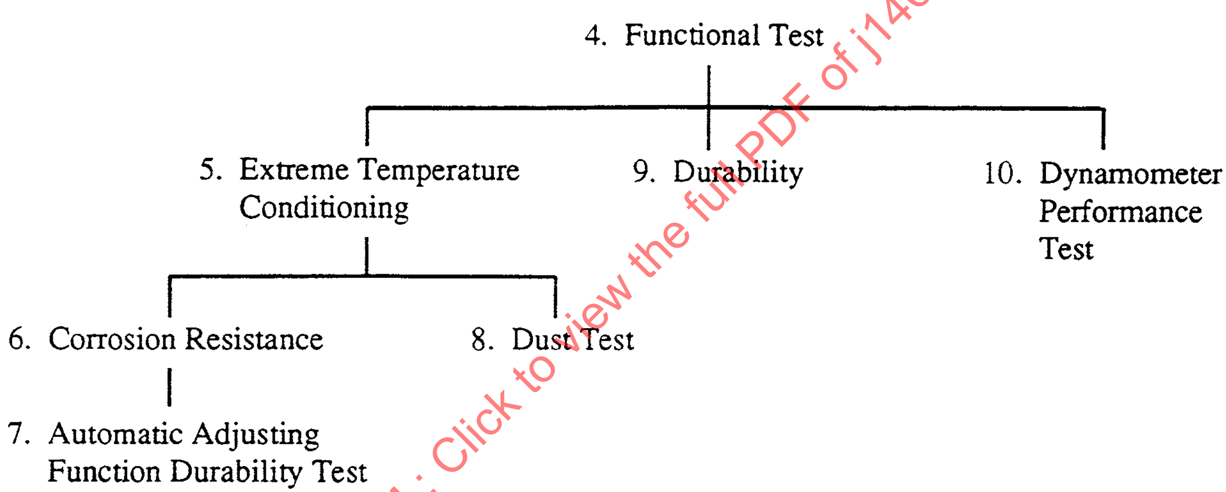
3. Units to be tested per the schedule shown in Figure 1.

4. FUNCTIONAL TEST

At ambient temperature of 27 °C ± 11 °C (80 °F ± 20 °F), the following functional tests should be performed.

4.1 Adjusting Torque

Per the manufacturer's recommendations, rotate the adjusting shaft until the worm wheel has made one revolution in the brake applied direction and then in the brake released direction. Record the maximum torque in each direction.



NOTE— No modifications such as cleaning, regreasing, or repairs are to be made from test to test except as outlined in 10.3.1.

FIGURE 1 - SEQUENCE OF TESTS

4.2 Backlash

Mount a brake adjuster in an appropriate rigid fixture so that no movement is allowed between the fixture and the worm wheel. Measure and record the free movement of the brake adjuster arm at a distance of 152.4 mm (6 in) from the center of the worm wheel by applying a torque of 6.78 N·m ± 0.34 N·m (60 in-lb ± 3 in-lb) in each direction. Rotate adjusting shaft such that the worm wheel rotates to a new position of 72 degrees ± 3 degrees from the previous position and make the backlash check. Repeat this procedure until five measurements have been made covering the worm wheel circumference. Measurements may be taken at any arm length; however, the data shall be factored in terms of 152.4 mm (6 in) arm lengths.

5. EXTREME TEMPERATURE CONDITIONING

5.1 Submerge the brake adjuster in tap water and pressurize the container to 21 kPa ± 7 kPa (3 psi ± 1 psi) for 24 h minimum.

5.2 Immediately, without drying, subject the brake adjuster and fixture to –40 °C ± 1.1 °C (–40 °F ± 2 °F) for 16 h minimum, then cycle three times with 5.1 cm ± 0.64 cm (2.00 in ± 0.25 in) initial stroke while still at –40 °C (–40 °F). Test set up per 6.3.1, 6.3.2, and 6.3.4 with 203 N·m (1800 lbf-in) applied torque.

5.3 Subject the brake adjuster and fixture to 70 °C ± 2.8 °C (158 °F ± 5 °F) for 16 h minimum, then cycle 100 times with 5.1 cm ± 0.64 cm (2.00 in ± 0.25 in) initial stroke while still at 70 °C (158 °F). Test set up per 6.3.1, 6.3.2, and 6.3.4 with 203 N·m (1800 lbf-in) applied torque.

5.4 Return to ambient conditions and remove the brake adjuster from the test fixture.

6. CORROSION RESISTANCE

6.1 Environmental Chamber

A salt-spray cabinet may be constructed with the following specifications:

a. Approximate size 457.2 mm x 457.2 mm x 304.8 mm (18 in x 18 in x 12 in) deep.

b. The chamber preferably is constructed of metal and lined with impervious plastic, rubber, or epoxy material.

c. All piping which contacts the salt solution should be of inert material such as plastic. A vent pipe to be installed to minimize back pressure.

d. An air chamber is to be mounted externally with the pushrod extending into the chamber, a suitable boot is to be used to minimize loss of solution.

e. The brake adjuster is to be mounted on a spline shaft which can be rotated to simulate lining wear.

f. A salt solution per 6.2.2 must be maintained to a depth of 50.8 mm ± 6.4 mm (2.00 in ± 0.25 in) during the test.

g. The exhaust air from the air chamber is to be piped into the solution reservoir. The force of the exhaust air, when directed into the solution, must be capable of splashing and totally covering the brake adjuster with solution.

6.2 Durability test with contamination. An ambient temperature of 27 °C ± 11 °C (80 °F ± 20 °F) must be maintained.

6.2.1 Mount brake adjuster in a sealed environmental chamber capable of splashing and totally covering the brake adjuster with solution during each application.

6.2.2 Mix a contaminated solution in the following proportions:

a. 850 mL—Distilled Water

b. 100 g—Coarse test dust (SAE J726b)

c. 45 g—Sodium Chloride (99.9% Pure Granular or Flake)

d. 5 g—Calcium Chloride (Technical Flake Grade)

6.3 General Test Set-Up

6.3.1 Position the brake adjuster as recommended by the manufacturer.

6.3.2 Establish a residual torque of 22.6 N·m ± 11.3 N·m (200 in-lbf ± 100 in-lbf) on the brake adjuster.

6.3.3 With the test torque applied and the brake adjuster adjusted to the previous requirements, position a shut-off device so that an overstroke of 6.4 mm (0.25 in) maximum at 152.4 mm (6 in) equivalent lever length will discontinue the test.

6.3.4 Apply the test torque against a resisting force resulting in a total deflection rate of 15 to 30 minutes (of a degree) minimum per 113 N·m (1000 in-lbf) torque.

6.3.5 Establish the necessary time cycle controls to obtain the torque application and release requirements per the following (based on 30 cpm):

a. Total cycle time of 4 s

b. Maximum application time 1.00 s

c. Minimum dwell time 1.00 s

d. Release to residual torque for balance of cycle time

6.3.6 To simulate lining wear, the worm wheel shall be rotated in the same direction that the load is applied at a rate of 0.5 degree per 250 cycles of test operation.

6.3.7 The brake adjuster test cycle shall be run in the following sequence at 9% of rated torque:

25 000 cycles with contamination
Rest for 72 h
25 000 cycles without contamination
25 000 cycles with contamination
Rest for 72 h
25 000 cycles without contamination

6.3.8 Record whether or not the brake adjuster triggered the shut-off device.

7. AUTOMATIC ADJUSTING FUNCTION DURABILITY TEST

Conduct this test at ambient temperature of 27 °C ± 11 °C (80 °F ± 20 °F).

7.1 General Test Setup

7.1.1 Position the brake adjuster as recommended by the manufacturer.

7.1.2 Establish a residual torque of 22.6 N·m ± 11.3 N·m (200 in-lbf ± 100 in-lbf) on the brake adjuster.

7.1.3 With the rated torque applied and the brake adjuster adjusted to the previous requirements, position a shut-off device so that an overstroke of 6.4 mm (0.25 in) maximum will discontinue the test. The overstroke is measured from a point on the lever arm 152.4 mm (6 in) from the center of the worm wheel.

7.1.4 Apply the test torque against a resisting force resulting in a total deflection rate of 15 to 30 minutes (of a degree) minimum per 113 N·m (1000 in-lbf) torque.

7.1.5 Establish the necessary time cycle controls to obtain the torque application and release requirements per the following:

a. Total cycle time of 4.0 s

b. Maximum application time of 1.0 s

c. Minimum dwell time 1.0 s

d. Release to residual torque for balance of cycle time

7.2 Gear Set and Automatic Adjustment Integrity Test

7.2.1 To simulate lining wear, the worm wheel shall be rotated in the same direction that the load is applied at a rate of 0.5 degrees per 160 cycles of test operation.

7.2.2 The brake adjuster test cycle shall be run in the following sequence:

TABLE 1 - BRAKE ADJUSTER TEST CYCLE SEQUENCE

Number of Cycles	Percent of Rated Torque
155 000	40
35 000	60
8500	80
1500	100

7.2.3 To simulate reline, where the brake adjuster may be backed off to accommodate the new lining, rotate the worm wheel 50 degrees against the direction that the load is applied at 50 000 cycle increments.

7.2.4 Record whether or not the brake adjuster triggered the shut-off device.

7.2.5 Repeat 7.1.3.

8. DUST TEST

8.1 Cubical box inside measurement of 900 mm (35.43 in) on each side.

8.2 Dust

4.5 kg (9.9 lb) powdered cement (ASTM C 150-56) spread evenly over the bottom of the box.

8.3 General test setup is the same as 7.1 mounted within the box at least 150 mm (5.9 in) from any wall.

8.4 Cycle at 20% of rated torque for 5000 applications and while cycling, the worm wheel shall be rotated in the same manner as 7.2.1.

8.5 During cycling, the dust shall be agitated at intervals of 15 min by compressed air or blower(s) by projecting a blast of air downward into the dust for a period of 2 s. The dust must be diffused throughout the entire cube.

8.6 Record whether or not the brake adjuster triggered the shut-off device.

9. DURABILITY

Conduct this test at ambient temperature of 27 °C ± 11 °C (80 °F ± 20 °F).

9.1 General Test Set-Up

9.1.1 Position the brake adjuster on the test fixture.

9.1.2 Adjust the brake adjuster so that with the rated torque (manufacturer's recommended load x effective lever length) applied, the actuator pushrod is perpendicular (90 degrees ± 3 degrees) to the effective lever arm of the brake adjuster.

9.1.3 Establish a residual torque of 22.6 N·m ± 11.3 N·m (200 in-lbf ± 100 in-lbf) on the brake adjuster. This simulates internal brake friction and brake return springs (where applicable).

9.1.4 With the rated torque applied and the brake adjuster adjusted to the previous requirements, position a shut-off device so that an equivalent overstroke of 6.4 mm (0.25 in) maximum at 152.4 mm (6 in) lever length will discontinue the test.

9.1.5 Apply the test torque per 9.2.2 against a resisting force resulting in a total deflection rate of 15 to 30 minutes (of a degree) minimum per 113 N·m (1000 in-lbf) torque.

9.1.6 Establish the necessary time cycle controls to obtain the torque application and release requirements per the following:

a. Total cycle time of 4.0 s

b. Maximum application time of 1.0 s

c. Minimum dwell time 1.0 s

d. Release to residual torque for balance of cycle time

9.2 Gear Set Integrity Test

9.2.1 Provide a reference mark on the adjusting shaft and worm wheel to assure return to original position after torque check 9.2.3.

9.2.2 The brake adjuster test cycle shall be run in the following sequence:

TABLE 2 - BRAKE ADJUSTER TEST CYCLE SEQUENCE

Number of Cycles	Percent of Rated Torque
155 000	40
35 000	60
8500	80
1500	100

9.2.3 Measure and record the adjustment torque per the following schedule:

Number of Cycles— 50 000
100 000
155 000
190 000
198 500
200 000

Per the manufacturer recommendations, rotate adjusting shaft five turns in brake applied direction and ten turns in brake released direction. Record maximum torque in each direction. Return the adjusting shaft to the original position and continue the test.

9.3 Housing Integrity Test

9.3.1 After completion of 9.2.3, continue cycling at rated torque for 30 000 cycles. Repositioning or replacing of the gear set or its equivalent is permissible at any time during the housing test.

9.3.2 Inspect for visible structural fractures through use of dye penetrant and record the findings.

10. DYNAMOMETER PERFORMANCE TEST

10.1 Purpose

To evaluate external automatic brake adjuster dynamic performance under various application pressures/decelerations and brake operating temperatures.

10.2 Scope

The dynamometer test is designed to look at the operational extreme conditions as well as the normal service conditions with respect to adjustment performance. The dynamometer test is not designed as an external automatic brake adjuster durability test.

10.3 Test Hardware

10.3.1 Foundation Brake

a. Double anchor pin cast spider

b. Cam same rotation

c. Camshaft based on a 12.7 mm (0.5 in) cam effective radius

d. S-Cam centerline to brake adjuster centerline dimension of 293.6 mm ± 3.1 mm (11.56 in ± 0.125 in)

e. Fabricated air chamber bracket assembly

f. Fabricated brake shoe

10.3.2 Hub and Drum Assembly

a. Cast iron drum 50.8 kg ± 2.3 kg (112 lb ± 5 lb)

10.3.3 Axle Spindle

a. R-Series rear axle spindle 10 433 kg (23 000 lb)

10.3.4 Air Chamber

a. Type 30/30

b. Rated stroke 64 mm (2.5 in)

c. Attach Air Chamber Input-Output Curve

10.3.5 External Automatic Brake Adjuster

a. Brake Adjuster Length—140 mm (5.5 in)

10.3.6 Brake Lining

a. Capable of meeting the requirements of FMVSS-121 for a 10 433 kg (23 000 lb) rating

10.4 Drum Preparation

10.4.1 Measure drum diameter, open and closed sides, and record per Appendix A.

10.4.2 On the outside of the drum, mill or spot-face a flat smooth surface, perpendicular to the radial centerline ("A" Figure A1), on an area measured one-half the distance of the brake rubbing surface from the open side. This flat surface shall not partially interfere with any circumferential strengthening rib; however, it may be machined wholly and totally on it.

10.4.3 Drill a 6.35 mm (0.25 in) hole at "B" Figure A1, perpendicular to the flat, and through the drum wall. Deburr hole at both ends.

10.4.4 Using a piece of shim stock 0.25 to 0.51 mm (0.010 to 0.020 in) held against the inner circumference of the drum, over the hole at "B" measure "D" with a depth micrometer. Measure thickness and record on Figure A1.

10.4.5 Measure drum rubbing surface finish axially along braking surface and record on Figure A1.

10.4.6 Weigh and record weight of drum only on Figure A1.

10.4.7 Measure drum hardness on a machined surface and record on Figure A1.

10.4.8 Using a spindle or axle end mount, assemble brake drum on wheel (or hub) and assemble on spindle. Refer to manufacturer recommendations for wheel-bearing adjustment. Measure drum run-out and record on Figure A1.

10.4.9 Record hub and drum axial end play on Figure A1.

10.4.10 Drum requirements for 10.4.1 and 10.4.4 through 10.4.9 are shown on Figure A1.

10.4.11 Thermocouple Drum

10.4.11.1 At a point diametrically opposite of the measurement hole "B" (11.4.3), drill a 3.18 mm (0.125 in) hole into the drum radially to a depth of 1.52 to 2.29 mm (0.060 to 0.090 in) from the rubbing surface. Do not drill all the way through.

10.4.11.2 Insert a standard 3.18 mm (0.125 in) plug type thermocouple into the hole to the maximum depth and peen the hole around the thermocouple lead to stake it in place. See Appendix B.

10.5 Brake Preparation

10.5.1 Friction Material

10.5.1.1 Before starting test, measure and record shoe and lining assembly thickness at room temperature as shown in Appendix C.

10.5.1.2 Leading shoe lining temperatures are to be monitored by plug type thermocouples per SAE J786a and Appendix B. The thermocouple will be located in the contacting lining surface and not within any grooves. Clearance between the lining surface and the thermocouple should be reset to the initial clearance after completion of burnish.

10.5.1.3 Maximum permissible gap between lining and shoe table is 0.08 mm (0.003 in) measured at the rivet heads and 0.20 mm (0.008 in) between rivet locations. Lining surfaces must be clean and free of grease, oil, paint, or any other foreign material which could affect their proper function.

10.5.1.4 Scribe a line across lining and table edges at each lining wear measurement point (see Appendix C). Use this scribe line as locators to measure lining to drum clearance and monitor any lining movement.

10.5.2 Brake Assembly

10.5.2.1 Assemble brake assembly onto axle shaft flange. Torque spider to flange fasteners per manufacturer recommendations.

10.5.2.2 Install a chamber stroke measurement device to measure the pushrod stroke.

10.6 Dynamometer Preparation

10.6.1 Dynamometer Test Calculations

a. Test Speed—As specified in the procedure, calculate rpm required as follows in Equation 1:

$$r/min = \frac{2654.78 \times km/h}{rr}\left(\frac{168.2 \times mpn}{rr}\right) \quad \text{(Eq. 1)}$$

where:

rr = specified tire rolling radius in millimeters (inches)
r/min = dynamometer revolutions per minute

b. Speed Correction Factor (SCF)—Calculate SCF to compensate for deviations (greater than or equal to ±1%) between the actual inertia and the requested inertia as follows in Equation 2:

$$SCF = [\text{actual static wheel load/specified static wheel load}]^{1/2} \quad \text{(Eq. 2)}$$

Once the SCF is found, the corrected test speed can be found from the specified test speed as follows in Equation 3:

$$\text{corrected test speed} = SCF \times \text{specified test speed} \quad \text{(Eq. 3)}$$

c. Inertia Calculation Formula—(See Equation 4.)

$$I = \frac{W\ (rr)^2}{138\ 079\,(144)\,g} \quad \text{(Eq. 4)}$$

where:

I = inertia required in kg-m^2 (slug-ft^2)
W = wheel load kg (lb) = $\frac{GAWR}{2}$
rr = tire rolling radius in millimeters (inches)
g = 9.815 m/s^2 (32.2 ft/s^2)

10.6.2 Dynamometer Inertia

Inertia for test determined by the formula in 10.6.1 is to be equivalent to the load on the wheel with the axle loaded to its gross axle weight rating.

10.6.3 Dynamometer Rate of Rotation

The rate of brake rotation on a dynamometer corresponding to the rate of rotation on a vehicle at a given speed is calculated by assuming a tire radius equal to the specified static loaded radius.

10.7 Dynamometer Commonalities

10.7.1 Test Parameters

10.7.1.1 Static Loaded Rolling Radius

541 mm (21.3 in).

10.7.1.2 Wheel Load

5216 kg (11 500 lb).

10.7.1.3 Cam rotation

Same as drum rotation.

10.7.2 Air Pressure Ramp Rate

Pressure build-up to 414 kPa (60 psi) in 0.45 s or less.

10.7.3 Maximum Chamber Pressure

Maximum pressure at brake air chamber governed at 758 kPa (110 psi).

10.7.4 Ambient Air Temperature

16 to 38 °C (60 to 100 °F).

10.7.5 Cooling Air

10.7.5.1 Air at ambient temperature directed uniformly and continuously over the brake at a velocity of 671 m/min ± 61 m/min (2200 ft/min ± 200 ft/min) as measured upstream of the brake in a 0.3048 m^2 (1 ft^2) duct.

10.7.5.2 The cooling air speed may be reduced if required to maintain a required temperature. Record any occurrences of speed modification.

10.7.6 Temperature Accuracy

All temperatures in this test are ±14 °C (±25 °F) unless otherwise noted.

10.7.7 Functional Requirements

A visual inspection after testing shall cover:

a. Condition of linings (cracks, flaking, etc.)

b. Condition of shoes (weld separation, shoe deformation, etc.)

c. Condition of drum (surface finish, color, etc.)

d. Condition of brake spider and S-camshaft (cracks, deformations, etc.)

e. Record observations

10.7.8 Cool Down

10.7.8.1 The brake temperature is decreased to a specified level by rotating the drum at a constant 48 km/h (30 mph), unless otherwise specified.

10.7.8.2 Allow the brake drum to cool down to or below 60 °C (140 °F). The brake lining must cool to within 37.8 °C (100 °F) of the brake drum, but must not exceed 65.6 °C (150 °F).

10.7.9 Zero Speed

Zero speed condition is defined as 0 to 7 rpm (maximum) to minimize rock-back dynamometer torque oscillations.

10.8 Data Reduction

10.8.1 Recorded Data

10.8.1.1 Record the following parameters for every snub or stop:

a. Speed (rpm)

b. Air Chamber Inlet Pressure (Peak)

c. Lining Temperature (Initial and Peak)

d. Drum Temperature (Initial and Peak)

e. Maximum Stroke During Stop or Snub

f. Stop Time

10.8.1.2 Data as Specified in Procedure

a. Lining Wear

b. Static Brake Adjuster Stroke

c. Shoe to Drum Clearance

d. Average Drag Torque

e. Peak Drag Torque

f. Static Automatic Adjustment Curve

g. Static Brake Stiffness

10.8.1.3 Calculated Data

a. Deceleration Rate

b. Stop Time Torque

10.8.1.4 Reduced and Tabulated Data

a. Peak Air Pressure

b. Initial and Peak Lining Temperatures

c. Initial and Peak Drum Temperatures

d. Maximum Chamber Stroke

e. Stop Time

10.8.2 Stop Time

Measured off trace from the specified test speed (V_1) is reached until the brake attains a speed of seven (maximum) revolutions per minute.

where:

V_I = test velocity in m/s (ft/s) at 542 N·m (400 lbf-ft) of brake torque

10.8.3 Deceleration

Deceleration will be calculated using the stop time as determined in 10.8.4, initial test velocity (V_I) and final velocity (V_F) at the end of the stop or snub as follows in Equation 5:

$$\text{Deceleration} = \frac{V_I - V_F}{\text{stop time}} \quad \text{(Eq. 5)}$$

where:

V_F = final velocity in m/s (ft/s)

10.8.4 Stop Time Torque

Using the deceleration from 10.8.3, stop time torque can be calculated using the wheel load and rolling radius using Equation 6:

$$\text{Torque} = \frac{\text{deceleration} \times \text{wheel load} \times \text{static loaded tire radius}}{9.815\,(32.17)} \quad \text{(Eq. 6)}$$

10.9 Dynamometer Procedure

10.9.1 Static Automatic Adjustment

10.9.1.1 Adjust brake to produce 63.5 mm ± 3.1 mm (2.5 in ± 0.125 in) of stroke at 207 kPa ± 34 kPa (30 psi ± 5 psi) of application pressure.

10.9.1.2 Measure system average and peak drag torque to the nearest 11.3 N·m (100 lbf-in) and record on Figure D1. These are labeled as the residual torque values.

10.9.1.3 With brake drum and lining at ambient conditions, develop a static automatic adjustment curve. Make up to a maximum of 250 static brake applications at 207 kPa (30 psi) and record stroke on each application. Fewer applications can be made if the stroke stabilizes for 10 consecutive applications.

10.9.1.4 Measure system average and peak drag torque to the nearest 11.3 N·m (100 lbf-in) and record on Figure D1.

10.9.2 Static Brake Stiffness

10.9.2.1 If the brake is hot, allow the brake drum to cool down to the requirements of 10.7.8.2.

10.9.2.2 In the static condition, apply brake with line pressure of 34 (5), 69 (10), 138 (20), 207 (30), 276 (40), 345 (50), 414 (60), 483 (70), 552 (80), 586 (85), 621 (90), and 690 kPa (100 psi) . Record chamber stroke and line pressure.

NOTE: One continuous application to keep the automatic brake adjuster from adjusting.

10.9.2.3 With the brake in the released position, measure the shoe to drum clearance, through the 6.4 mm (0.25 in) hole, at four locations on each shoe. Measure clearance after rotating drum to the line inscribed on the edge of the shoe corresponding to the lining measurement points established in Appendix C for a total of eight measurements. Record shoe to drum clearance measurement on Figure C2.

10.9.3 Burnish

10.9.3.1 Make 200 stops from 64 km/h (40 mph) at a deceleration of 3 m/s^2 (10 ft/s^2), with an initial drum temperature on each stop of not less than 157 °C (315 °F) and not more than 196 °C (385 °F).

10.9.3.2 Make 200 additional stops from 64 km/h (40 mph) at a deceleration rate of 3 m/s^2 (10 ft/s^2) with an initial drum temperature of not less than 232 °C (450 °F) and not more than 288 °C (550 °F). Lining temperature will be monitored, recorded, and reduced during the burnish, the first, fiftieth, and every fiftieth stop thereafter.

10.9.3.3 Allow brake to cool (see 10.7.8.2).

10.9.3.4 Measure system average and peak drag torque to the nearest 11.3 N·m (100 lbf-in) and record on Figure D1.

10.9.3.5 Conduct static brake stiffness per 10.9.2.

10.9.3.6 Remove drum.

10.9.3.7 Inspect contact area to determine degree of burnish. If contact area is less than 90% per shoe, repeat 10.9.3.2 to 10.9.3.7 until proper contact area is achieved. Measure shoe and lining thickness at the 16 reference points and record on Figure C2. Replace drum.

10.9.3.8 Repeat static automatic adjustment by conducting 10.9.1.1 and 10.9.1.3.

10.9.4 Deceleration Controlled Test (232 °C (450 °F))

10.9.4.1 Warm brake and drum assembly to a drum temperature of 232 °C (450 °F) by making snubs from 64 to 32 km/h (40 to 20 mph) at 0.6 m/s^2 (2 ft/s^2).

10.9.4.2 Conduct 500 applications 64 to 32 km/h (40 to 20 mph) snubs, with initial brake drum temperature of 232 °C (450 °F) with torque control per Schedule X (Appendix E, Figure E1).

10.9.4.3 The 500th brake application from 10.9.4.2 is to be a full stop from 64 km/h (40 mph). With no drum rotation and spring brake applied, allow the brake drum to cool down as specified in 10.7.8.2.

10.9.4.4 Release the spring brake.

10.9.5 Adjustment Inspection

10.9.5.1 With the brake cooled per 10.7.8.2, measure the drag torque as a result of any automatic brake over-adjustment. This should be checked through one revolution of the brake drum. Record average and peak drag torque values on Figure C2, and compare to the residual torques established in 10.9.1.2.

10.9.5.2 **(Optional)** Measure shoe to drum clearance per 10.9.2.3.

10.9.5.3 Repeat static brake stiffness per 10.9.2.2. Record 586 kPa (85 psi) brake adjuster stroke on Figure D1.

10.9.5.4 **(Optional)** Disassemble wheel and drum from brake assembly. Measure shoe and lining thickness at the 16 reference points. Reassemble wheel and drum to brake assembly.

10.9.6 Deceleration Controlled Test (121 °C (250 °F))

10.9.6.1 Repeat wear (10.9.4) except use initial drum temperature of 121 °C (250 °F).

10.9.6.2 Repeat adjustment inspection per 10.9.5.

10.9.7 Deceleration Controlled Test (Refuse Packer Schedule) 232 °C (450 °F)

10.9.7.1 Repeat 10.9.4 except use 500 applications with torque control per Schedule Y (Appendix F, Figure F1) and use an initial drum temperature of 232 °C (450 °F).

10.9.7.2 Repeat adjustment inspection per 10.9.5.

10.9.8 Deceleration Controlled Test (Refuse Packer Schedule) 343 °C (650 °F)

10.9.8.1 Repeat 10.9.4 except use 500 applications with torque control per Schedule Y (Appendix F, Figure F1) and use an initial drum temperature of 343 °C (650 °F).

10.9.8.2 Repeat adjustment inspection per 10.9.5.

10.9.9 Pressure Controlled Test

10.9.9.1 Repeat static automatic adjustment by conducting 10.9.1.1 and 10.9.1.3.

10.9.9.2 Warm brake and drum assembly to a drum temperature of 121 °C (250 °F) by making snubs from 64 to 32 km/h (40 to 20 mph) at 0.6 m/s^2 (2 ft/s^2).

10.9.9.3 Conduct 100 snubs from 64 to 32 km/h (40 to 20 mph) with an initial drum temperature of 121 °C (250 °F) while maintaining a constant application pressure of 69 kPa (10 psi).

10.9.9.4 The 100th snub from 10.9.9.3 is to be a full stop from 64 km/h (40 mph). With no drum rotation and brake released, allow the brake to cool to the requirements of 10.7.8.2.

10.9.9.5 Repeat adjustment inspection per 10.9.5.

10.9.9.6 Warm brake and drum assembly to a drum temperature of 232 °C (450 °F) by making snubs from 64 to 32 km/h (40 to 20 mph) at 0.6 m/s^2 (2 ft/s^2).

10.9.9.7 Conduct 100 snubs from 64 to 32 km/h (40 to 20 mph) with an initial drum temperature of 232 °C (450 °F) while maintaining a constant application pressure of 552 kPa (80 psi).

10.9.9.8 The 100th snub from 10.9.9.7 is to be a full stop from 64 km/h (40 mph). With no drum rotation and brake released, allow the brake to cool to the requirements of 10.7.8.2.

10.9.9.9 Repeat adjustment inspection per 10.9.5.

10.9.9.10 Warm brake and drum assembly to a drum temperature of 343 °C (650 °F) by making snubs from 64 to 32 km/h (40 to 20 mph) at 0.6 m/s^2 (2 ft/s^2).

10.9.9.11 Conduct 100 snubs from 64 to 32 km/h (40 to 20 mph) with initial drum temperature of 343 °C (650 °F) while maintaining a constant application pressure of 345 kPa (50 psi).

10.9.9.12 The 100th snub from 10.9.9.11 is to be a full stop from 64 km/h (40 mph). With no drum rotation and brake released, allow the brake to cool to the requirements of 10.7.8.2.

10.9.9.13 Repeat adjustment inspection per 10.9.5.

10.9.9.14 Warm brake and drum assembly to test temperature by making snubs from 64 km/h (40 mph) at 0.6 m/s^2 (2 ft/s^2).

10.9.9.15 Conduct 100 snubs from 64 to 32 km/h (40 to 20 mph) with initial drum temperature of 343 °C (650 °F) while maintaining a constant application pressure of 552 kPa (80 psi).

10.9.9.16 The 100th snub from 10.9.9.15 is to be a full stop from 64 km/h (40 mph). With no drum rotation and brake released, allow the brake to cool to the requirements of 10.7.8.2.

10.9.9.17 Repeat adjustment inspection per 10.9.5.

10.9.9.18 Repeat static automatic adjustment by conducting 10.9.1.1 and 10.9.1.3.

10.10 Static Data Analysis Requirements

10.10.1 Static Brake Stiffness Curves

10.10.1.1 Pre Burnish

10.10.1.2 Post Burnish

10.10.1.3 Test Conclusion

10.10.2 Shoe-to-Drum Clearance (List Each Reading, Shoe Average, Brake Average)

10.10.2.1 Pre Burnish

10.10.2.2 Post Burnish

10.10.2.3 Post Deceleration Control Tests

10.10.2.4 Post Pressure Control Tests

10.10.3 587 kPa (85 psi) Stroke Measurement

10.10.3.1 Post Burnish

10.10.3.2 Post Deceleration Control Tests

10.10.3.3 Post Pressure Control Tests

10.10.4 Brake Drag Torque Readings (List for Deceleration and Pressure Control Test) Both Average and Peaks

10.10.4.1 Pre Burnish

Before and after static adjust down.

10.10.4.2 Post Burnish

10.10.4.3 Post Deceleration Control Tests

10.10.4.4 Post Pressure Control Tests

10.10.5 Static Automatic Adjustment Strokes

Plot for each temperature in the pressure and deceleration control test sequences.

10.10.5.1 Pre Burnish

10.10.5.2 Post Burnish

10.10.5.3 Post Deceleration Control Tests

10.10.5.4 Post Pressure Control Tests

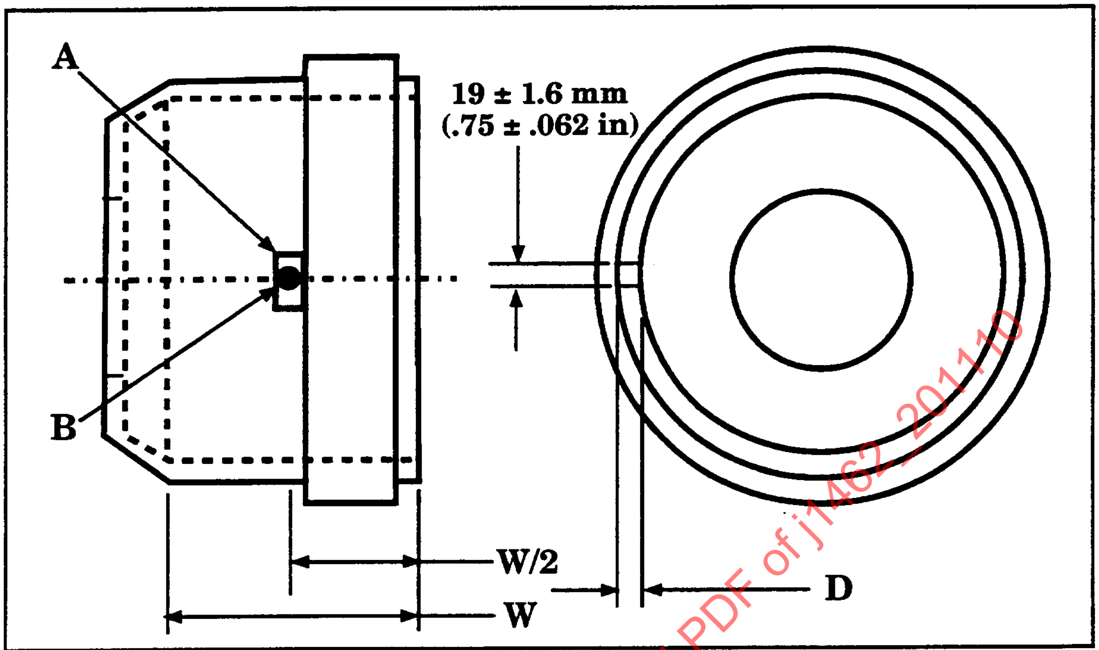
11. NOTES

11.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE TRUCK AND BUS FOUNDATION BRAKE COMMITTEE
OF THE SAE TRUCK AND BUS BRAKE AND STABILITY CONTROL STEERING COMMITTEE

APPENDIX A



SECTION	MEASUREMENT	VALUE	REQUIREMENTS
10.4.1	DRUM DIAMETER - OPEN		418.97 - 419.23 mm (16.495 - 16.505 in)
10.4.1	DRUM DIAMETER - CLOSED		418.97 - 419.23 mm (16.495 - 16.505 in)
10.4.4	"D"		
10.4.5	DRUM SURFACE FINISH		5.08 µm MAXIMUM (200 µin MAXIMUM)
10.4.6	DRUM WEIGHT		51 ± 2.3 kg (112 ± 5 lb)
10.4.7	DRUM HARDNESS		187 - 241 BHN
10.4.8	DRUM RUNOUT		0.33 mm MAXIMUM (0.013 in MAXIMUM)
10.4.9	AXIAL END PLAY		0.25 mm MAXIMUM (0.01 in MAXIMUM)

FIGURE A1 - DRUM DATA SHEET

APPENDIX B

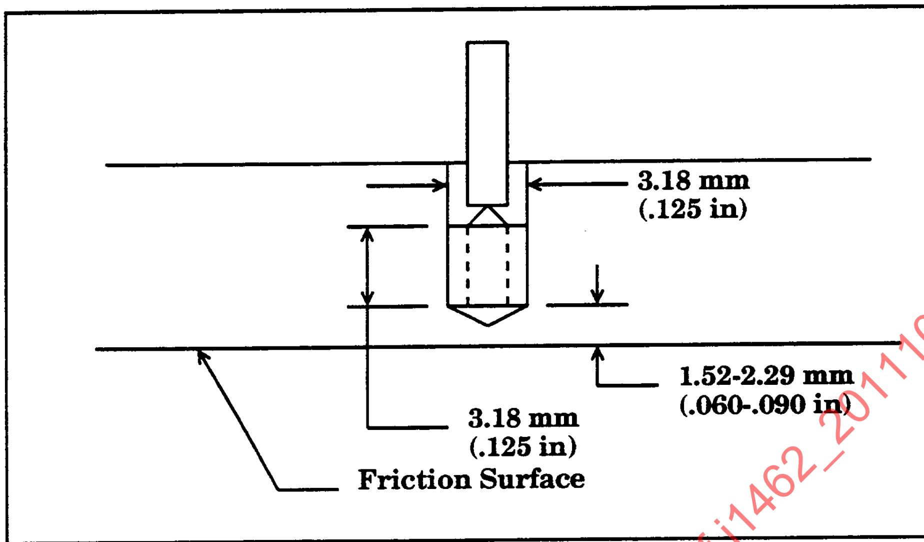


FIGURE B1 - DRUM THERMOCOUPLE INSTALLATION

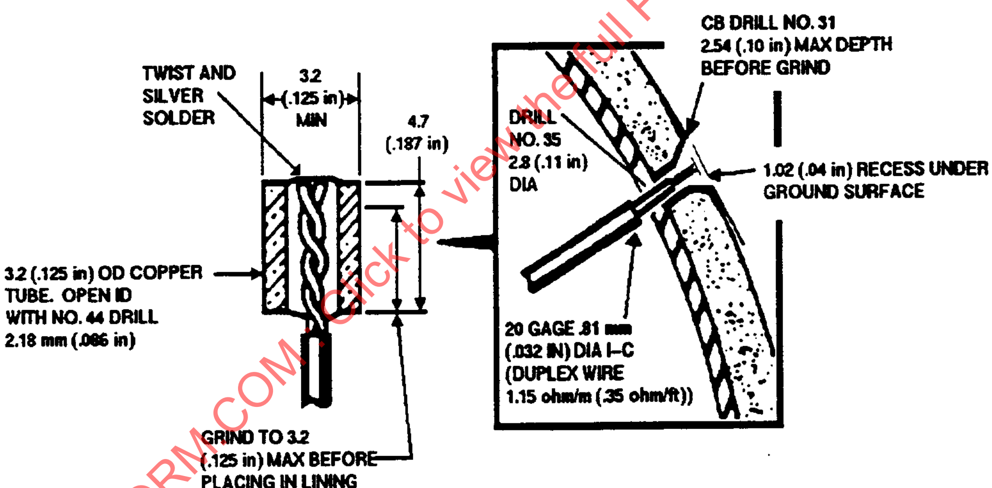
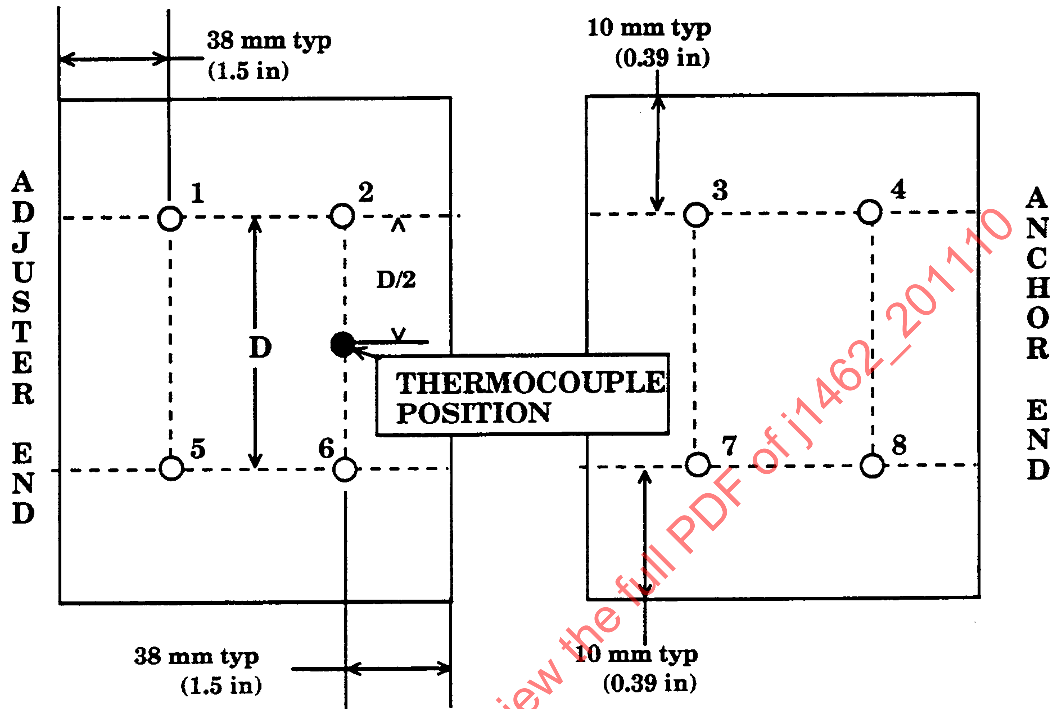


FIGURE B2 - LINING THERMOCOUPLE INSTALLATION

APPENDIX C



1. **Locate lining wear measurement points as shown (○).**
   - **A. Mark leading and trailing shoes.**
   - **B. Dimple wear measurement points with drill and use a ball micrometer to measure.**
2. **Install thermocouple mid way between lining wear measurement points 2 and 6.**

FIGURE C1 - LINING WEAR MEASUREMENTS

SHOE LOCATION	SECTION NUMBER	POINT 1	POINT 2	POINT 3	POINT 4	TEST CONTROL
PRIMARY	10.9.2.3					DECELERATION
SECONDARY	10.9.2.3					DECELERATION
PRIMARY	10.9.5.2					DECELERATION
SECONDARY	10.9.5.2					DECELERATION
PRIMARY	10.9.6.2					DECELERATION
SECONDARY	10.9.6.2					DECELERATION
PRIMARY	10.9.7.1					DECELERATION
SECONDARY	10.9.7.1					DECELERATION
PRIMARY	10.9.8.2					DECELERATION
SECONDARY	10.9.8.2					DECELERATION
PRIMARY	10.9.9.4					DECELERATION
SECONDARY	10.9.9.4					PRESSURE
PRIMARY	10.9.9.9					PRESSURE
SECONDARY	10.9.9.9					PRESSURE
PRIMARY	10.9.9.13					PRESSURE
SECONDARY	10.9.9.13					PRESSURE
PRIMARY	10.9.9.17					PRESSURE
SECONDARY	10.9.9.17					PRESSURE

FIGURE C2 - LINING CLEARANCE MEASUREMENTS