

	SURFACE VEHICLE STANDARD		J2115		REV. AUG2006
			Issued	1993-06	
			Revised	2006-08	
		Superseding	J2115 JUN2000		
(R) Air Brake Performance and Wear Test Code Commercial Vehicle Inertia Dynamometer					

RATIONALE

This revision of the SAE J2115 includes several enhancements and fine-tuning relative to the previous version. The main objectives for the revision were to bring it closer to the FMVSS 121 dynamometer test, focus on air brake systems, and to update the wear sections to reflect current industry practices for durability testing. This revision limits the scope to air-braked vehicle applications only. There are provisions for disc and drum brakes. The test conditions include parameters and response characteristics for the servo controller on the inertia-dynamometer. The test setup provides an alternate method for measuring drum or disc bulk temperature using a 9-thermocouple array. Wear sections reflect better current industry practice for assessing wear characteristics versus temperature. The wear sections include intermediate effectiveness evaluation at the corresponding temperature step as well as a baseline temperature of 100 °C. These effectiveness sections help assess any changes or trends on brake output as an effect of the material wear and the temperature history during previous sections. Temperature steps are better harmonized with International Standards for disc brakes. Lastly, Appendix A indicates the FMVSS 121 performance requirements during the different test sections for air brake systems used on different tractors, trailers or other commercial vehicle applications.

1. SCOPE

This SAE Standard provides test procedures for air and air-over-hydraulic disc or drum brakes used for on-highway commercial vehicles over 4536 kg (10 000 lb) of GVWR. This recommended practice includes the pass/fail criteria of Standard No. 121.

1.1 Purpose

To provide an FMVSS121-based performance test and a wear and performance at increasing brake temperatures for disc and drum assemblies.

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.

2.1.1 Federal Publications

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

49CFR571 Code of Federal Regulations Sec. 571.121 Standard No. 121 (Revised as of October 1, 2004)

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3. TESTS

This document procedure includes the following inertia-dynamometer tests:

3.1 FMVSS121-based performance.

3.2 Wear and Performance at increasing temperatures.

4. INSTRUMENTATION, EQUIPMENT, AND TEST CONDITIONS

Inertia should be equivalent to the loading conditions at which the brake normally operates within + 1% or - 1%. Calculate rotational speeds based on the Static Loaded Radius (SLR) for the tires normally used to carry such loads. Calculate the dynamometer inertia on the SLR and half the Gross Axle Weight Rating (GAWR).

4.1 Thermocouples

4.1.1 Plug Type Thermocouple

Plug style thermocouple as shown in Figure 1.

4.1.2 Lining Thermocouple

4.1.2.1 Install thermocouple in brake shoe lining as shown in Figures 2 and 3 for drum brakes.

4.1.2.2 Install thermocouple in brake pad lining as shown in Figure 5 for disc brakes (adjust installation location for grooves, chamfers...)

4.1.3 Drum/Disc Thermocouple(s)

Note the two methods indicated below are not equivalent and may produce different results.

4.1.3.1 Standard method for drum or disc: Install thermocouple in drum or disc as shown in Figures 3, 4 and 6.

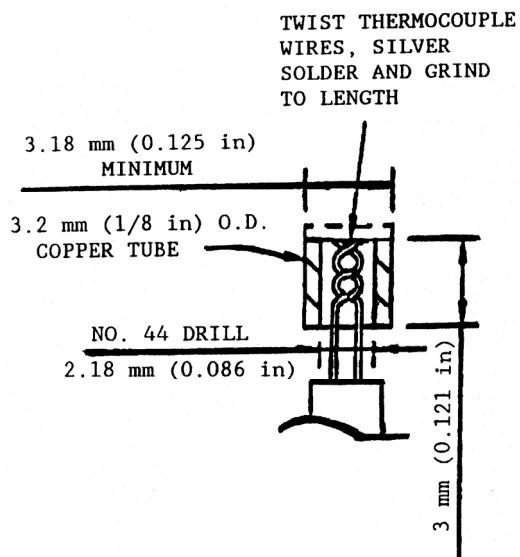


FIGURE 1 – THERMOCOUPLE CONSTRUCTION

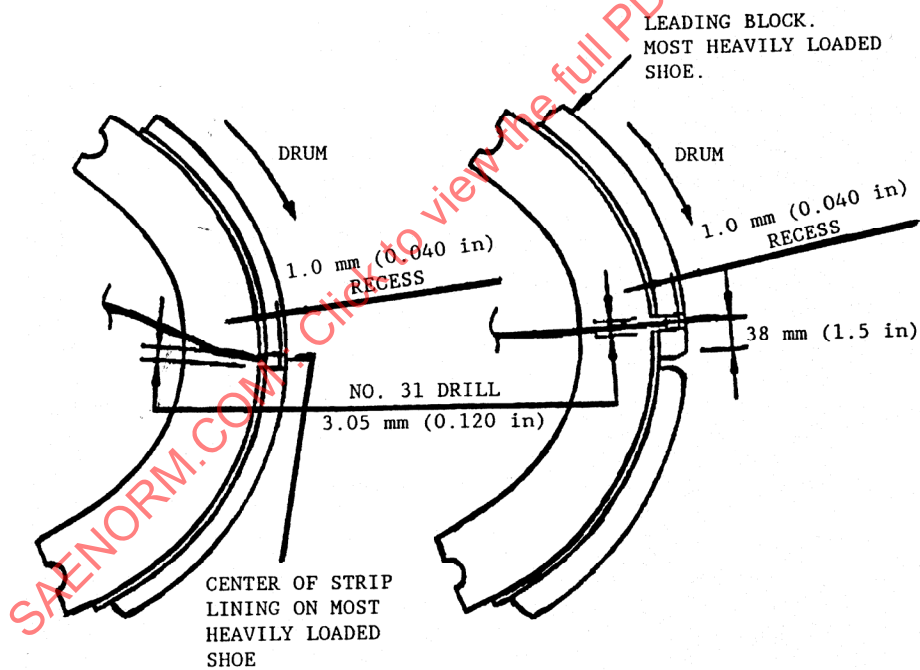


FIGURE 2 – BRAKE SHOE THERMOCOUPLE INSTALLATION

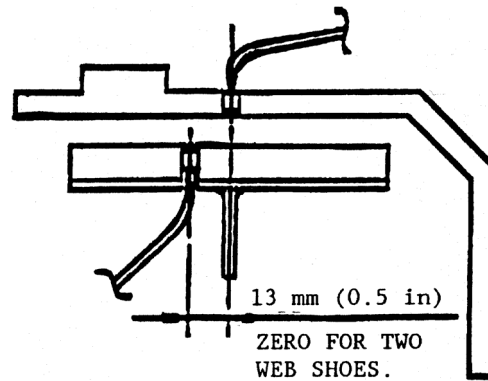


FIGURE 3 – DRUM THERMOCOUPLE AND SINGLE WEB SHOE THERMOCOUPLE LOCATION

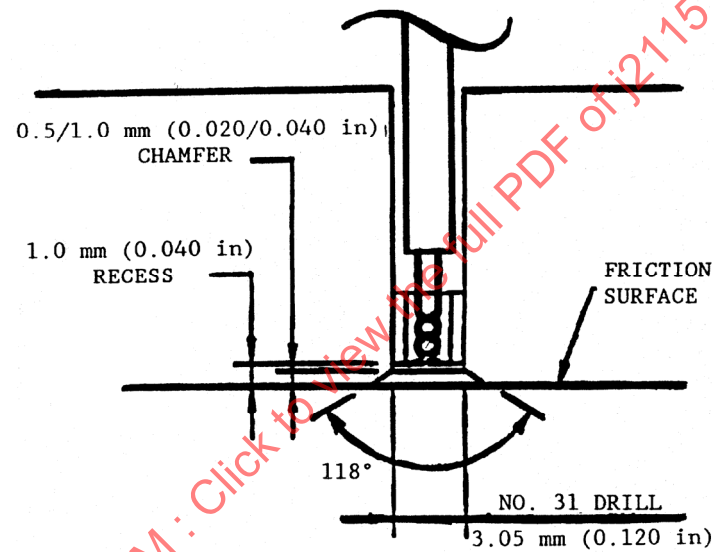


FIGURE 4 – DRUM OR DISC THERMOCOUPLE INSTALLATION

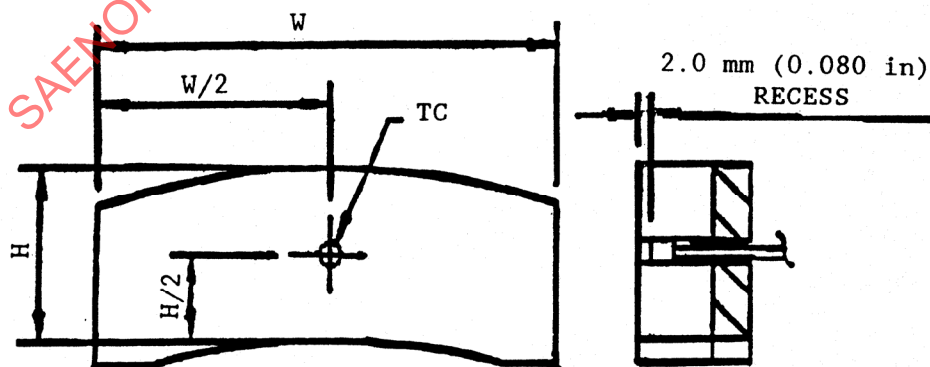


FIGURE 5 – PAD THERMOCOUPLE LOCATION

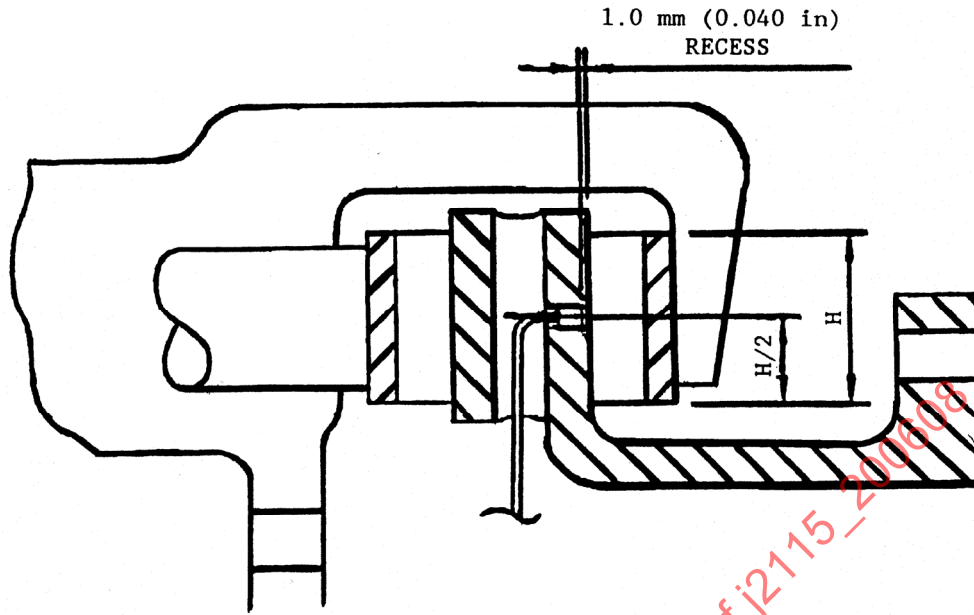
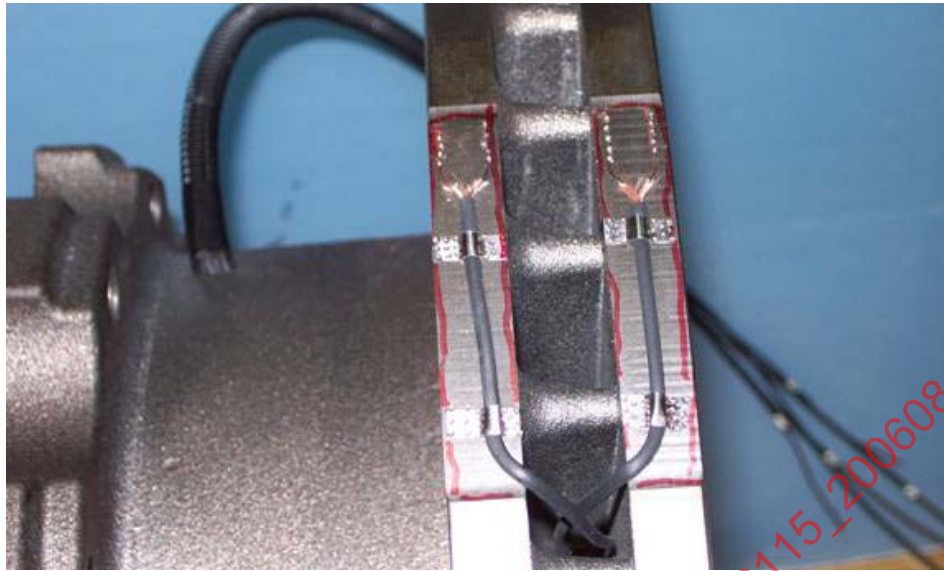


FIGURE 6 - DISC

- 4.1.3.2 Optional method for drum or disc: Install a 3x3 thermocouple array in drum or disc as shown in Photographs 1, 2 and 3. Place a group of three thermocouples every 120 degrees around the drum or disc circumference.



PHOTOGRAPH 1 – DISC INSIDE DIAMETER



PHOTOGRAPH 2 – DISC OUTSIDE DIAMETER



PHOTOGRAPH 3 – DRUM

4.2 Cooling Air

Cooling air velocity shall be 609 - 730 m/min (2000 – 2400 ft/min) and directed uniformly and continuously over the brake at a temperature between 24 °C (75 °F) and 38 °C (100 °F), except as specified in wear sections (see 7.6 and 7.7, below).

4.3 Brake Pressure Control

- 4.3.1 Pressure response time of less than 0.25 seconds to reach 414 kPa (60 psi) during onset of deceleration (brake apply).

4.3.2 Maximum overshoot of 14 kPa (2 psi) that does not last over 0.2 seconds.

4.3.3 Control pressure within + 7 kPa (+1 psi).

4.3.4 Control of Average (not instantaneous) deceleration (as defined) + 0.1m/sec² (+ 0.33 ft/sec²) with a maximum pressure modulation of 138 kPa/sec (20 psi/sec) after onset of deceleration.

4.3.5 Do not exceed 745 kPa (108 psi) during the brake application.

5. DEFINITIONS

5.1 Anti-lock braking system (ABS)

Portion of the service brake system that automatically controls the degree of rotational wheel slip on one or more road wheels of the vehicle during braking. The ABS system uses wheel speed sensors, a control unit and pressure modulating valves to perform the braking control.

5.2 Average Deceleration Rate

The change in velocity divided by the time elapsed measured from the onset of deceleration to final speed. Use the same interval (start and end points) for both, the change in velocity and the elapsed time.

5.3 Cooling Air Velocity

Compute the cooling air velocity by dividing the airflow (cubic meter/min) inside the duct before the plenum by the open area (square meter) remaining around the brake in the plenum measured at right angles to the nominal airflow direction.

5.4 Cycle Time

Time elapsed from the initiation of one application to the initiation of the next. The times allotted for Brake Power and Recovery of Section 6 (FMVSS121-based dynamometer test) are calculated based on the nominal application durations for the specified speeds and decelerations rounded to the nearest second.

5.5 Gross Axle Weight Rating (GAWR)

The specified load-carrying capacity of a single axle system measured at the tire-ground interface.

5.6 Wheel Load

Wheel load is one-half of the GAWR.

5.7 Initial Brake Lining Temperature (IBLT)

Temperature of friction material of hottest brake shoe or pad 18 seconds before any brake application. This is used only for the FMVSS121-based performance portion of test (Section 6).

5.8 Maximum Pressure

Maximum line pressure applied from the point at which the instantaneous deceleration exceeds 95% of the specified Average Deceleration Rate (5.2, above) during onset of deceleration until the final speed.

5.9 Minimum Pressure

Minimum line pressure applied from the point at which the instantaneous deceleration exceeds 95% of the specified Average Deceleration Rate (5.2, above) during onset of deceleration until the final speed.

5.10 Pressure

Force per unit area exerted by the compressed air in the brake application mechanism.

5.11 Retardation Torque

Measure the average reference torque from the time the specified air pressure is reached until the brake is released.

5.12 Retardation Force

Divide the Retardation Torque (5.11, above) by the static loaded tire radius to determine the retardation force.

5.13 Retardation Force Ratio

Multiply the Retardation Force (5.12, above) by 2 and divide by the GAWR to determine the Retardation Force Ratio.

5.14 Snub

Brake application to decrease speed to a value greater than 0 km/h (not a full stop).

6. FMVSS121-BASED DYNAMOMETER TEST

6.1 Burnish

Adjust brake per brake manufacturer specification. If required, adjust the brake up to three times during the burnish procedure.

- 6.1.1 Warm to 177 °C (350 °F) by performing the listed events until temperature after stop exceeds 177 °C (350 °F). Reduce cycle time (below 90 sec) if required to reach temperature.

TABLE 1

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
~	64.4 km/h (40 mph)	0 km/h (0 mph)	3.0 m/sec ² (10 ft/sec ²)	~	~	90 sec

First burnish.

TABLE 2

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
200	64.4 km/h (40 mph)	0 km/h (0 mph)	3.0 m/sec ² (10 ft/sec ²)	~	177 °C (350 °F)	~

- 6.1.2 Warm to 260 °C (500 °F) by making stops until the temperature after stop exceeds 260 °C (500 °F). Reduce cycle time (below 60 sec) if required to reach temperature.

TABLE 3

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
~	64.4 km/h (40 mph)	0 km/h (0 mph)	3.0 m/sec ² (10 ft/sec ²)	~	~	60 sec

Second burnish.

TABLE 4

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
200	64.4 km/h (40 mph)	0 km/h (0 mph)	3.0 m/sec ² (10 ft/sec ²)	~	260 °C (500 °F)	~

- 6.1.3 Cool brake by rotating at 10 RPM until brake cools below 38 °C (100 °F).

6.2 Performance

Adjust brake per brake manufacturer specification, if required.

6.2.1 Warm to 80 °C (176 °F) by performing the listed events until the temperature after stop exceeds 80 °C (176 °F).

TABLE 5

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
~	64.4 km/h (40 mph)	0 km/h (0 mph)	3.0 m/sec ² (10 ft/sec ²)	~	~	90 sec

Brake Retardation.

TABLE 6

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	138 kPa (20 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	207 kPa (30 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	276 kPa (40 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	345 kPa (50 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	414 kPa (60 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	483 kPa (70 psi)	80 °C (176 °F)	~
1	80.5 km/h (50 mph)	0 km/h (0 mph)	~	552 kPa (80 psi)	80 °C (176 °F)	~

Brake Power, Hot Stop and Recovery.

TABLE 7

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	IBLT	Cycle Time
1	80.5 km/h (50 mph)	24.1 km/h (15 mph)	2.7 m/sec ² (9 ft/sec ²)	~	80 °C (176 °F)	~
9	80.5 km/h (50 mph)	24.1 km/h (15 mph)	2.7 m/sec ² (9 ft/sec ²)	~	~	72 sec
1	32.2 km/h (20 mph)	0 km/h (0 mph)	4.3 m/sec ² (14 ft/sec ²)	~	~	66 sec
1	48.3 km/h (30 mph)	0 km/h (0 mph)	3.7 m/sec ² (12 ft/sec ²)	~	~	122 sec
19	48.3 km/h (30 mph)	0 km/h (0 mph)	3.7 m/sec ² (12 ft/sec ²)	~	~	60 sec

7. WEAR AND EFFECTIVENESS AT TEMPERATURE

7.1 Wear Test Preparation

Prepare a new set of brake shoes or pads and drum or disc with thermocouples.

- Weigh and measure brake shoes or pads.
- Weigh and measure brake drum or disc.

7.2 Wear Burnish

7.2.1 Warm to 100 °C (212 °F) by making snubs at 60 second intervals until temperature after snub exceeds 100 °C (212 °F).

TABLE 8

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	Initial Drum	Initial Disc
~	64.4 km/h (40 mph)	32.2 km/h (20 mph)	0.9 m/sec ² (3 ft/sec ²)	~	~	~

7.2.2 Wear Burnish

TABLE 9

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	Initial Drum	Initial Disc
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	100 °C (212 °F)	100 °C (212 °F)
200	64.4 km/h (40 mph)	32.2 km/h (20 mph)	0.9 m/sec ² (3 ft/sec ²)	~	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	100 °C (212 °F)	100 °C (212 °F)

7.2.3 Post Wear Burnish Inspection

- Vacuum brake shoes or pads and wipe off grease prior to measuring.
- Weigh and measure brake shoes or pads.
- Measure brake drum or disc (weight not required).
- Reset lining thermocouple depth to 3 mm (0.12 inch).

7.3 First Wear

7.3.1 First Wear (includes initial applications below temperature).

TABLE 10

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	Initial Drum	Initial Disc
1000	64.4 km/h (40 mph)	32.2 km/h (20 mph)	0.9 m/sec ² (3 ft/sec ²)	~	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	121 °C (250 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	100 °C (212 °F)	~
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	100 °C (212 °F)	~
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	100 °C (212 °F)	~
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	100 °C (212 °F)	~
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	100 °C (212 °F)	~

7.3.2 Post First Wear Inspection

- Vacuum brake shoes or pads and wipe off grease prior to measuring.
- Weigh and measure brake shoes or pads.
- Measure brake drum or disc (weight not required).
- Reset lining thermocouple depth to 3mm (0.12 inch).

7.4 Second Wear

7.4.1 Second Wear (includes initial applications below temperature).

TABLE 11

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	Initial Drum	Initial Disc
1000	64.4 km/h (40 mph)	32.2 km/h (20 mph)	0.9 m/sec ² (3 ft/sec ²)	~	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	177 °C (350 °F)	200 °C (392 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	100 °C (212 °F)	100 °C (212 °F)

7.4.2 Post Second Wear Inspection

- Vacuum brake shoes or pads and wipe off grease prior to measuring.
- Weigh and measure brake shoes or pads.
- Measure brake drum or disc (weight not required).
- Reset lining thermocouple depth to 3mm (0.12 inch).

7.5 Third Wear

7.5.1 Third Wear (includes initial applications below temperature).

TABLE 12

Cycles	Initial Speed	Final Speed	Average Deceleration	Pressure	Initial Drum	Initial Disc
1000	64.4 km/h (40 mph)	32.2 km/h (20 mph)	0.9 m/sec ² (3 ft/sec ²)	~	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	232 °C (450 °F)	300 °C (572 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	138 kPa (20 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	276 kPa (40 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	414 kPa (60 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	552 kPa (80 psi)	100 °C (212 °F)	100 °C (212 °F)
1	80.5 km/h (50 mph)	0.5 km/h (0.3 mph)	~	690 kPa (100 psi)	100 °C (212 °F)	100 °C (212 °F)

7.5.2 Post Third Wear Inspection

- Vacuum brake shoes or pads and wipe off grease prior to measuring.
- Weigh and measure brake shoes or pads.
- Measure brake drum or disc (weight not required).
- Reset lining thermocouple depth to 3 mm (0.12 inch).