



SURFACE VEHICLE RECOMMENDED PRACTICE

J3006™

DEC2024

Issued 2014-10
Reaffirmed 2020-05
Stabilized 2024-12

Superseding J3006 MAY2020

Low-Duty Inertia Dynamometer Hydraulic Brake Wear Test Procedures
for Vehicles Above 4536 kg (10000 pounds) of GVWR

RATIONALE

This procedure has been in use by various brake manufacturers and OEMs since the late 1990s. It was issued as an SAE Recommended Practice in 2014. The committee does not anticipate the need for any changes in the foreseeable future.

STABILIZED NOTICE

This document has been declared "STABILIZED" by SAE Truck and Bus Hydraulic Brake Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2024 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, or used for text and data mining, AI training, or similar technologies, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: SAE J3006_202412

For more information on this standard, visit https://www.sae.org/standards/content/J3006_202412/

Documents

Standard, visit Sharing Hub

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose	3
2.	REFERENCES.....	3
2.1	Related Publications	3
3.	DEFINITIONS	3
4.	TEST CYCLE	6
4.1	Dynamic Brake Application	6
4.2	Time t_0	6
4.3	Time t_1	6
4.4	Time t_2	6
4.5	Time t_3	7
4.6	Time t_4	7
5.	TEST EQUIPMENT.....	7
6.	TEST CONDITIONS	7
7.	TEST PARTS PREPARATION AND TEST SETUP	8
8.	BRAKE DRAG, FLUID DISPLACEMENT, AND BRAKEAWAY TORQUES	12
9.	TEST PROCEDURES.....	12
9.1	Low-Duty Wear versus Temperature Test – Method A	12
9.2	Low-Duty Wear at Fixed Temperature Test – Method B	14
10.	TEST REPORT	15
11.	NOTES.....	16
11.1	Marginal Indicia	16
APPENDIX A	GUIDELINES FOR TARGET WEAR VALUES (INFORMATIVE).....	17
APPENDIX B	SAMPLE TABULAR WEAR REPORTS FOR DISC BRAKES UNDER METHOD A.....	18
FIGURE 1	TYPICAL BRAKE APPLICATION TIME STAMPS	6
FIGURE 2	COOLING AIR FLOW DIRECTION RELATIVE TO CALIPER POSITION.....	8
FIGURE 3	PLUG-TYPE THERMOCOUPLE FOR BRAKE ROTOR	9
FIGURE 5	WEAR MEASUREMENT POSITIONS FOR DRUM BRAKES – (A) LEADING SHOE; (B) TRAILING SHOE.....	10
TABLE 1	WEAR VERSUS TEMPERATURE TEST SEQUENCE – METHOD A	13
TABLE 1	WEAR VERSUS TEMPERATURE TEST SEQUENCE – METHOD A (CONTINUED).....	14
TABLE 2	FIXED TEMPERATURE WEAR TEST SEQUENCE – METHOD B.....	14
TABLE 2	FIXED TEMPERATURE WEAR TEST SEQUENCE – METHOD B (CONTINUED).....	15

1. SCOPE

This Recommended Practice is derived from OEM and tier-1 laboratory tests and applies to two-axle multipurpose passenger vehicles, or trucks with a GVWR above 4536 kg (10 000 pounds) equipped with hydraulic disc or drum service brakes. Before conducting testing for a specific brake sizes or under specific test conditions, review, agree upon, and document with the test requestor any deviations from the test procedure. Also, the applicable criteria for the final test results and wear rates deemed as significantly different require definition, assessment, and proper documentation; especially as this will determine whether or not Method B testing is needed.

This Recommended Practice does not evaluate or quantify other brake system characteristics such as performance, noise, judder, ABS performance, or braking under extreme temperatures or speeds. Minimum performance requirements are not part of this recommended practice. Consistency and margin of pass/fail of the minimum requirements related to wear rates and wear behavior can be assessed as part of the project in coordination with the test requestor.

NOTE: This Recommended Practice uses the unit conversion and rounding techniques from the NIST Special Publication 811. This to ensure the use of standard conversion factors and to determine the appropriate number of significant digits to ensure the Rounding Error (RE) of the converted unit is smaller than or similar to the RE of the original English or Imperial unit.

1.1 Purpose

The purpose of this procedure is to assess wear levels and wear rates at different brake temperatures or at fixed temperature with extended wear cycles during conditions that correspond to low-duty braking using single-ended inertia dynamometer tests.

2. REFERENCES

2.1 Related Publication

The following publication is provided for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 NIST Publications

Available from NIST, Gaithersburg, MD 20899, <http://physics.nist.gov/cuu/pdf/sp811.pdf>

NIST Special Publication 811; 2008 Edition - Guide for the Use of the International System of Units (SI)

Besides internal or proprietary information or requirements, no other publications constitute a required part of this document.

3. DEFINITIONS

3.1 APPARENT FRICTION FOR DISC BRAKES

Per Equation 1:

$$\mu = \frac{k_1 \cdot T}{2 \cdot (p - p_{threshold}) \cdot A_p \cdot r_{eff} \cdot \eta} \quad (\text{Eq. 1})$$

where:

μ = apparent friction for disc brakes. [unitless]

3.2 DRUM BRAKE EFFECTIVENESS (C^*)

Per Equation 2:

$$C^* = \frac{k_1 \cdot T}{(p - p_{threshold}) \cdot A_p \cdot R_{eff} \cdot \eta} \quad (\text{Eq. 2})$$

where:

C^*	= effectiveness for drum brakes. [unitless]
T	= output torque. [N·m], [lb·ft]
p	= brake pressure. [kPa], [lbf/in²]
$p_{Threshold}$	= minimum pressure required to start developing braking torque. [kPa], [lbf/in²]
A_p	= total piston area acting on one side of the caliper for disc brakes; total wheel cylinder area for drum brakes [mm²], [in²]
R_{eff}	= radial distance from centerline of the piston to the axis of rotation for disc brakes; internal drum diameter divided by 2 for drum brakes, unless other dimensions are provided by the requestor. [mm], [in]
η	= Brake efficiency ÷ 100 [unitless]
k_1	= Unit conversion factor; $k_1 = 1 \times 10^6$ for SI units; and $k_1 = 12$ for English units

3.3 BRAKE CORNER

Assembly of the foundation brake including friction material, caliper or wheel cylinder assembly with mounting hardware, brake rotor or drum, and wheel hub assembly excluding wheel and tire.

3.4 BRAKING FORCE DISTRIBUTION

Ratio between the braking force of each axle and the total braking force for the vehicle, expressed as a percentage for each axle (e.g. 50% front, 50% rear). For the decelerations of interest in this procedure, the total braking force distribution between the front and the rear axle is a function of the corresponding brake sizes, tire sizes, and the coefficient of friction (or brake effectiveness for drum brakes).

3.5 BREAKAWAY AND SUSTAINED ROTATIONAL TORQUE

Torque required to initiate brake rotation and measured for one complete revolution, measured 30 seconds after releasing any pressure acting on the brake.

3.6 DECELERATION-CONTROLLED BRAKE APPLICATION

Inertia-dynamometer control algorithm which adjusts brake pressure in real time to maintain a constant torque output calculated from the instantaneous deceleration specified in the test procedure.

3.7 PRESSURE-CONTROLLED BRAKE APPLICATION

Inertia-dynamometer control algorithm that maintains a constant input pressure to the brake irrespective of the torque output.

3.8 TORQUE-CONTROLLED BRAKE APPLICATION

Inertia-dynamometer control algorithm which adjusts brake pressure in real time to maintain a constant torque output independently from the instantaneous deceleration.

3.9 INITIAL BRAKE TEMPERATURE – IBT

Brake rotor (or drum) temperature at the start of the service brake application. [°C], [°F]

3.10 GROSS VEHICLE WEIGHT RATING – GVWR

Maximum vehicle weight declared by the vehicle manufacturer. [kgf], [lbf]

3.11 GROSS AXLE WEIGHT RATING – GAWR

Maximum axle sprung weight declared by the manufacturer. When multiple axle component ratings are available instead of a unique value for the axle, use the lowest rating declared. [kgf], [lbf]

3.12 LIGHTLY LOADED VEHICLE WEIGHT – LLVW

Unloaded vehicle weight plus 227.0 kg (500 lbf) (including driver and test instrumentation). [kgf], [lbf]

3.13 TIRE DYNAMIC ROLLING RADIUS

Equivalent tire radius that generates for a specific tire size the revolutions-per-mile published by the tire manufacturer. Use Equation 3 for SI units and Equation 4 for English units. Use the tire dynamic rolling radius to calculate the dynamometer rotational speed for a given linear vehicle speed and the test inertia.

$$\text{SI units} \quad R_{dyn} = \frac{1\,609\,344}{2 \cdot \pi \cdot \text{RevolutionsPerMile}} \quad (\text{Eq. 3})$$

$$\text{English units} \quad R_{dyn} = \frac{63\,360}{2 \cdot \pi \cdot \text{RevolutionsPerMile}} \quad (\text{Eq. 4})$$

where:

R_{dyn} = tire dynamic rolling radius. [mm] using Equation 3; [in] using Equation 4

Revolutions Per Mile = tire manufacturer specification for revolutions per mile. Typically shown for the tire size on the manufacturer's website

3.14 WHEEL LOAD

Portion of the total vehicle weight braked by the tested corner. Wheel load is a function of the vehicle load condition (LLVW or GVWR) and the brake force distribution per item 3.4. Unless otherwise specified, use 25% of the GVWR. [kg], [lb]

3.15 TEST INERTIA

Mechanical or simulated (electrical) inertia to replicate the rotational energy input as a function of the reflected wheel load braked by the corner and the tire dynamic rolling radius using Equation 5. [kg·m²], [lbf·ft²]

$$I = k_2 \cdot W \cdot R_{dyn}^2 \quad (\text{Eq. 5})$$

where:

I	= test inertia. [kg·m ²], [slug·ft ²]
k_2	= unit conversion factor. $k_2 = 1$ for SI units. $k_2 = 2.16 \times 10^{-4}$ for English units
W	= wheel load per item 3.14
R_{dyn}	= tire dynamic rolling radius per item 3.13

3.16 SNUB

A service brake deceleration from a higher reference speed to a lower reference speed equal to or greater than 5 km/h (3.1 mph).

3.17 STOP

A service brake deceleration from a higher reference speed to a lower reference speed equal to or lower than 0.8 km/h (0.5 mph).

4. TEST CYCLE

4.1 Dynamic Brake Application

Figure 1 illustrates the main time-stamps used to characterize the brake application.

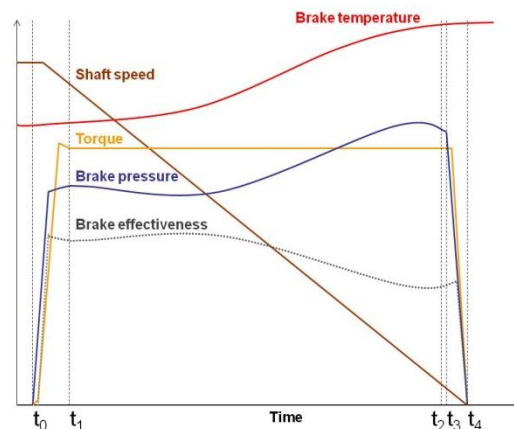


FIGURE 1 – TYPICAL BRAKE APPLICATION TIME STAMPS

4.2 Time t_0

Brake application initiation. At this time, the pressure starts to rise.

4.3 Time t_1

Time at level reached. At this time, the brake reaches its target level for deceleration, pressure, or torque control. At time t_1 , the calculation of average-by-time and the average-by-distance begins.

4.4 Time t_2

Time at the end of the averages. At time t_2 , the inertia-dynamometer data acquisition system terminates the calculation of average-by-time and average-by-distance. Time t_2 is the end of the stable portion of the brake application. t_2 is defined as the time at which speed is 0.5 km/h above the release speed (t_3).