



VEHICLE EQUIPMENT SAFETY COMMISSION

Regulation V-3

**MINIMUM REQUIREMENTS AND UNIFORM TEST
PROCEDURES FOR MOTOR VEHICLE BRAKE LININGS**

**Approved August 1968
Amended July 1980
Amended August 1982**

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FOR MOTOR VEHICLE BRAKE LININGS**

Approved August 1988
Amended July 1990
Amended August 1992

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MINIMUM REQUIREMENTS AND UNIFORM TEST PROCEDURES FOR MOTOR VEHICLE BRAKE LININGS

1. **PURPOSE**—To provide state administrators with equipment approval guidelines for motor vehicle brake linings through: (A) The establishment of a uniform test procedure for securing and reporting the friction wear characteristics of brake lining material, and (B) The establishment of minimum coefficient of friction requirements for brake linings used in the service brake system of motor vehicles.

2. **SCOPE**—This regulation covers brake linings used on motor vehicles operated on the public ways except those linings used only for parking brakes.

3. DEFINITIONS

3.1 **BRAKE LINING** — A part of a brake which absorbs energy in slowing or stopping the rotation of a wheel through friction when forced against a brake drum or disc of more durable material.

3.2 **CLASSIFICATION** — A category consisting of and determined by "normal" and "hot" coefficients of friction as set forth under subdivisions 7.2 and 7.3 of this regulation into which a brake lining or formulation falls and under which an approval is issued.

3.3 **COMMISSIONER** — The appropriate state official or state agency responsible for promulgating rules and regulations governing vehicle equipment approval and/or use of motor vehicles. The Commissioner or his designated agent may issue a certificate of approval.

3.4 **FORMULATION** — A specified mixture of materials from which brake linings are made and the corresponding sequence of production processing which together determine the characteristics of the brake lining.

3.5 **MANUFACTURER** — (1) A person, firm, association or corporation which makes a brake lining, or (2) A person, firm, association or corporation which sells or distributes a brake lining made by another manufacturer providing such brake lining is sold or distributed by such person, firm, association or cor-

poration under a name different from that under which the brake lining is sold or distributed by the maker and provided that such person, firm, association or corporation submits such brake lining for approval under his own name as manufacturer.

4. PREPARATION AND PROCEDURE

- 4.1 TEST PROCEDURE** — The test procedure for determination of coefficient of friction of brake linings and the change of coefficient with variables of temperature and time shall be as follows:
- 4.2 TEST APPARATUS** — The test apparatus shall consist of a Friction Materials Test Machine as described in SAE J661a and shown in Figures 1 and 2 and shall be equipped to accurately determine the wear and frictional characteristics of a brake lining. The heating curve and the cooling curve characteristics of the friction machine used in the test, based on the change of drum temperature as a function of time when the drum is running free, is to be recorded as illustrated in Figures 3 and 4.
- 4.3 PREPARATION OF TEST DRUM SURFACE** — The test drum surface shall be prepared as follows:
- (A) A new or resurfaced drum shall be ground in position on the test machine, and all grinder marks shall be removed and the surface finished with no. 320 grit (wet or dry) sandpaper only. The dust shall be removed from the drum by means of a vacuum, liquid cleaning method, or by wiping with clean cheese cloth or equivalent. A preliminary sample of the lining to be tested shall then be run continuously at a drum speed of 417 rpm (20 fps), a lining force against the drum of 100 lb. and a drum temperature not exceeding 200F until the coefficient of friction has stabilized.
 - (B) Prior to each test, the drum surface shall be finished with no. 320 grit (wet or dry) sandpaper only. The dust shall be removed from the drum by means of vacuum, liquid cleaning method, or by wiping with clean cheese cloth or equivalent.
- 4.4 SELECTION OF TEST SPECIMENS** — The test specimen shall be taken from the center of a lining segment equidistant from each end. The sample shall be 1 in. square, flat on the bottom, with the radius of the working surface conforming to the radius of the test drum.

- 4.5 **PREPARATION OF TEST SPECIMEN** – The thickness of the test specimen (or specimen plus shim of like material) shall be approximately 0.240 in. measured in the center of the specimen. Not less than 0.010 nor more than 0.020 in. shall be removed from the working surface of a curved specimen. On specimens cut from 0.250 in. or greater nominal thickness linings, the excess material shall be removed from the bottom side of the specimen. In cases where nominal lining thicknesses are less than 0.210 in., the minimum amount of material shall be removed from the bottom to produce flatness, and the bottom shall be shimmed with like material to the total thickness specified above. The working surface of the specimens shall not be handled and shall be kept free of foreign material.
- 4.6 **CONDITIONS OF TEST SPECIMEN** – The specimen shall be run-in at a drum speed of 312 rpm (15 fps), a lining force against the drum of 100 lb. (100 psi), and a maximum drum temperature of 200F for 20 minutes. If the specimen does not show at least 95% contact after 20 minutes, it shall be discarded and another specimen prepared.
- 4.7 **INITIAL SPECIMEN-TO-DRUM CLEARANCE** – The initial clearance between the specimen and the drum shall be 0.010 to 0.015 in. with the test force removed and the machine in the off position after conditioning of the test specimen and before the first baseline run.

5. TEST RUNS

- 5.1 **TEST SPEED AND FORCE** – The following tests shall be run at a drum speed of 417 rpm (20 fps) and a lining load of 150 lb. (150 psi) against the drum.
- 5.2 **BASE LINE RUN** – The lining shall be run in cycles consisting of 10 second applied load and 20 second no load for 20 applications. The run shall be started at a drum temperature of 200F, and the temperature shall be maintained at an average of 200F throughout the run.
- 5.3 **FIRST FADE RUN** – The lining shall be run continuously with the heater on. The run shall be started at a drum temperature of 200F and shall be stopped when either 10 minutes or 550F is attained, whichever occurs first.
- 5.4 **FIRST RECOVERY RUN** – Immediately upon completion of the first fade run, the heater shall be turned off, and the blower

shall be turned on without stopping the drum. The lining shall be run with the load applied for 10 second periods starting at each 100F interval during cooling from 500F to 200F.

- 5.5 **WEAR RUN** – The lining shall be run in cycles consisting of 20 second applied load and 10 second no load for 100 applications. The run shall be started at a drum temperature of 400F, and the temperature shall be maintained by the heater or blower at an average 400F throughout the run.
- 5.6 **SECOND FADE RUN** – The lining shall be run continuously with the heater on and the blower off. The run shall be started at 200F and stopped when either 10 minutes or 650F is reached, whichever occurs first.
- 5.7 **SECOND RECOVERY RUN** – Immediately upon completion of the second fade run, the heater shall be turned off, and the blower shall be turned on without stopping the drum. The lining shall be run with the load applied for 10 second periods starting at each 100F interval during cooling from 600F to 200F.
- 5.8 **BASE LINE RERUN** – The lining shall be run in cycles consisting of 10 second applied load and 20 second no load for 20 applications. The run shall be started at a drum temperature of 200F, and the temperature shall be maintained at an average of 200F throughout the run.

6. RECORD OF TESTS

- 6.1 **NUMBER OF TESTS** – Five complete tests, including preparation and conditioning, shall be made for each brake lining submitted for approval.
- 6.2 **TEST REPORT** – The test data shall be reported on the forms shown in Figures 5 and 6.
- 6.3 **TEMPERATURE AND COEFFICIENT OF FRICTION** – Lining coefficient of friction shall be recorded for each run at the temperature and application numbers shown on the form in Figure 6, up to the limits specified for each run in Section 5. Data shall be recorded to 3 decimal places and averaged to 2 decimal places. For intermittent application runs, the coefficient shall be measured at the end of the application.

- 6.4 **TIME LIMIT** – If the specified temperature limits for the first or second fade runs are not reached within 10 minutes, the coefficient of friction attained at 10 minutes shall be recorded at each higher temperature test point.

7. DETERMINATION OF COEFFICIENT OF FRICTION CLASS CODING

- 7.1 **IDENTIFICATION OF FRICTION CHARACTERISTICS** – For the purposes of identification of brake linings according to their friction characteristics, a letter code shall be employed. There shall be two conditions under which coefficients are classified: Normal friction and hot friction. The following letter codes shall be used to determine coefficient of friction:

CLASS CODE	COEFFICIENT OF FRICTION
C	Not over 0.15
D	Over 0.15 but not over 0.25
E	Over 0.25 but not over 0.35
F	Over 0.35 but not over 0.45
G	Over 0.45 but not over 0.55
H	Over 0.55

The coefficient of friction of each lining shall be identified by two consecutive letters, the first to represent the defined level of normal friction, and the second letter to represent the defined level of hot friction.

- 7.2 **NORMAL FRICTION COEFFICIENT** – The friction coefficient is that coefficient which is the numerical average of the four points located at 200, 250, 300 and 400F on the second fade curve of the Data Sheet (see figure 6) on which the average of five test runs is recorded.
- 7.3 **HOT FRICTION COEFFICIENT** – The hot friction coefficient is that coefficient which is the numerical average of the following ten points on the Data Sheet (see Figure 6) on which the average of five test runs is recorded: Points at 400 and 300F on the first recovery run; Points at 450, 500, 550, 600 and 650F on the second fade run; Points at 500, 400, and 300F on the second recovery run.

8. REQUIREMENTS FOR APPROVAL

8.1 CLASS CODE LIMITS – No brake lining shall be approved which:

- (A) Has a normal friction coefficient below that of code class E.
- (B) Has a hot coefficient below that of code class D.
- (C) Exhibits a coefficient of friction below 0.150 on any of the five tests at any of the following points:
 - (i) Between 200F and 550F inclusive on the second fade run
 - (ii) Between 300F and 200F inclusive on the second recovery run

No lining shall be approved exhibits more than a 20 percent or 0.050 variation of coefficient of friction, whichever is greater, below the average value of all five tests at each temperature point specified in paragraph C of this subdivision.

Where an original equipment lining will not meet the class code limits above, approval will be granted upon advice of that lining's friction coding and certification to the agency that the lining is used in an original equipment brake system meeting federal braking regulations. Further, where an original equipment lining is approved based on this exception, the agency will approve upon application other brake linings with code limits no lower than the original equipment lining for replacement use in that same application.

- 8.2 APPROVAL AGENCY –** The commissioner or his designated agent may issue a certificate of approval to the manufacturer upon receipt of the test data showing compliance of the lining with this regulation.
- 8.3 WAIVER OF REQUIREMENTS –** The requirements of this section may be waived at the discretion of the Commissioner with respect to brake linings for special purpose vehicles or unusual brake designs subject to such conditions which will assure safety as the Commissioner may prescribe in each specific case.
- 8.4 SPECIFIC USE –** Approval of a brake lining as being in a specific coefficient of friction class does not constitute ap-

proval by the Commissioner for installation of that lining in all vehicles or in any particular make or model of vehicle unless specifically stated. Brakes of different types require different levels of coefficient of friction which can be categorized among the levels adopted. The coefficient of friction classes do not substitute for the use of matched sets for particular installations.

9. IDENTIFICATION REQUIREMENTS

- 9.1 ORDER OF IDENTIFYING CODE** – Every brake lining sold shall be identified to show the manufacturer, the catalog or formulation designation, and the coefficient of friction classification of such brake lining.
- 9.2 METHOD OF IDENTIFICATION** – Brake linings, whether in an unmounted or bulk supply form, mounted on brake shoes or pads or as brake blocks, shall be indelibly marked with good contrast on an external non-contacting surface in letters not less than 7/64 in. in height where a lining is 1/8 in. or greater in thickness, or no more than 1/64 in. less than the thickness of the lining where the lining thickness is of less than 1/8 in. The numbers and code letters giving the name under which approved, the catalog or formulation number, and code letters indicating the coefficient of friction classification of the lining shall be marked in that order. The name shall be abbreviated by not less than two letters.

REFERENCE MATERIALS

SAE – Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, (412) 776-4841

SAE J661a "SAE Recommended Practice: Brake Lining Quality Control Test Procedure"

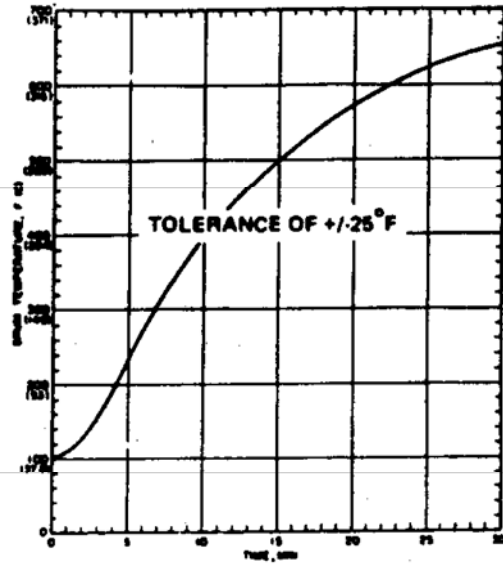


FIG. 3—STANDARD DRUM HEATING CURVE, FRICTION MATERIALS TEST MACHINE

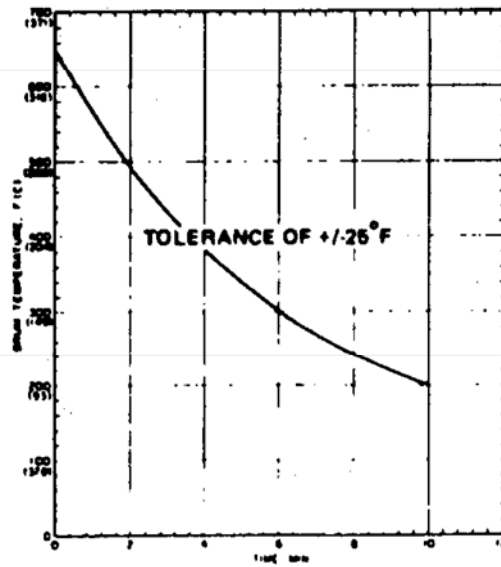


FIG. 4—STANDARD DRUM COOLING CURVE, FRICTION MATERIALS TEST MACHINE

BRAKE LINING TEST REPORT

Manufacturer's Name _____

Identification Markings _____

Summary of Results from Data Sheet

Normal Friction Coefficient = Average of "N" Value =
(Shall be over 0.25) Class

Hot Friction Coefficient = Average of "H" Value =
(Shall be over 0.15) Class

Lowest Coefficient for readings marked (*) =
(Shall not be lower than 0.15)

Maximum absolute variation below average for readings marked (*) =
(Shall not exceed 0.050 unless percentage variation is 20% or less)

Maximum percentage variation for readings marked (*) exceeding 0.050 below average =

I certify the above results were obtained on tests conducted in accordance with Vehicle Equipment Safety Commission Regulation V-3 on a five sample lot from linings submitted by the manufacturer as being representative of those regularly manufactured and marked by him.

Date: _____ Signature: _____

Firm: _____

Address: _____

FIG 5- DATA SHEET SUMMARY

**BRAKE LINING TEST REPORT
DATA SHEET**

IDENTIFICATION MARKINGS _____

COEFFICIENT OF FRICTION

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average	Maximum Variation Below Average
App. No. Baseline Run							
20							
Temp. First Fade Run							
200 F							
550 F							
or Temp. @ 10 Min.	F	F	F	F	F		
Temp. First Recovery Run							
500 F							
400 F						H	
300 F						H	
200 F							
App. No. Wear Run							
100							
Temp. Second Fade Run							
200 F	*	*	*	*	*	N	
250 F	*	*	*	*	*	N	
300 F	*	*	*	*	*	N	
400 F	*	*	*	*	*	N	
450 F	*	*	*	*	*	H	
500 F	*	*	*	*	*	H	
550 F	*	*	*	*	*	H	
600 F							
650 F							
or Temp. @ 10 Min.	F	F	F	F	F		
Temp. Second Recovery Run							
600 F							
500 F						H	
400 F						H	
300 F	*	*	*	*	*	H	
200 F	*	*	*	*	*		
App. No. Baseline Run							
20							

FIG 6 MASTER FORM DATA SHEET

VE
SC