Technical Report Preprint

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SOCIETY OF AUTOMOTIVE ENGINEERS, INC.
485 Lexington Avenue, New York 17, New York

J880

BRAKE RATING SYSTEM TEST CODE - COMMERCIAL VEHICLES - SAE J880

SAE Recommended Practice

Report of Brake Committee approved November 1963.

1. PURPOSE

The purpose of this code is to provide a method for determining a brake system rating for new commercial highway vehicles, based on the energy absorption and dissipation capacity of the brake system, as established by a repeated test procedure.

2. SCOPE

The code provides test procedures and instructions for:
Instrumentation and equipment.
Vehicle preparation.
Determining brake system energy absorption capacity.
Calculation of a brake rating.

The code includes provision for those vehicles, single unit, combinations, or special, which cannot be loaded to the manufacturer's rated gross vehicle weight, cannot be accelerated in the time interval required, or cannot attain the specified 50 mph speed.

Methods for measuring energy absorption capacity, other than described herein, may be equally valid.

3. INSTRUMENTATION AND EQUIPMENT

Each chassis to be checked must be equipped with:

3.1 A "U" tube decelerometer.

3.2 A fifth wheel speed indicator or calibrated speedometer or tachometer.

3.3 A detonator or equivalent to measure stopping distance.

3.4 A calibrated line pressure gage. (See paragraph 4.5.)

3.5 A 50 ft tape.

3.6 A stop watch or timing device.

3.7 A brake thermocouple selector switch and 0-1000 F direct reading pyrometer. (Brake temperature measurement equipment and thermocouple installation to conform to Sections A and B of SAE J786, SAE Brake System Road Test Code - Truck and Bus.

3.8 A reservoir bleedoff means to limit service line pressure to maximum permitted.

3.9 General Data Sheet (Fig. 1) to be filled in prior to starting test.

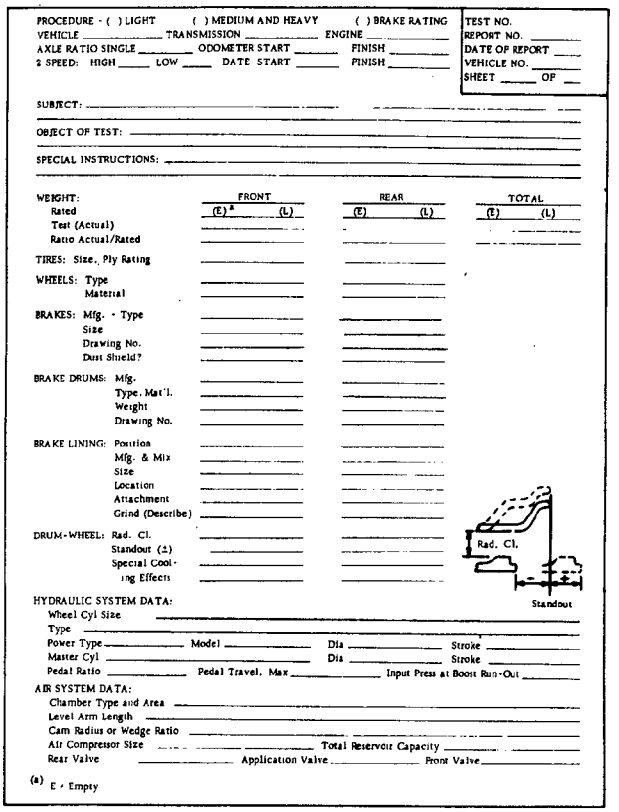
3.10 Brake Rating Test Data Sheet (Fig. 2) for use during the tests.

It should be noted that the maximum individual brake temperatures are not to be used as a criteria for brake rating. The measurement of brake temperatures as an index of brake condition during the test is necessary to provide test control and preclude an overly ambitious rating cycle.

4. VEHICLE CONDITION

To rate the brake system properly, the vehicle should:

4.1 Be loaded to rated gvw. The weight must be distributed as closely as possible to load each axle to its rated load. The center of gravity should be kept as low as possible. This can be accomplished by the proper selection of chassis, wheelbase, and type of weight used.


PROCEDURE - ( ) LIGHT ( ) MEDIUM AND HEAVY ( ) BRAKE RATING
VEHICLE _____ TRANSMISSION _____ ENGINE _____
AXLE RATIO SINGLE _____ ODOMETER START _____ FINISH _____
2 SPEED: HIGH _____ LOW _____ DATE START _____ FINISH _____

TEST NO.
REPORT NO.
DATE OF REPORT
VEHICLE NO.
SHEET _____ OF _____

SUBJECT:
OBJECT OF TEST:
SPECIAL INSTRUCTIONS:

	FRONT (E)[a]	FRONT (L)	REAR (E)	REAR (L)	TOTAL (E)	TOTAL (L)
WEIGHT: Rated						
Test (Actual)						
Ratio Actual/Rated						
TIRES: Size, Ply Rating						
WHEELS: Type						
Material						
BRAKES: Mfg. - Type						
Size						
Drawing No.						
Dust Shield?						
BRAKE DRUMS: Mfg.						
Type, Mat'l.						
Weight						
Drawing No.						
BRAKE LINING: Position						
Mfg. & Mix						
Size						
Location						
Attachment						
Grind (Describe)						
DRUM-WHEEL: Rad. Cl.						
Standout (±)						
Special Cooling Effects						

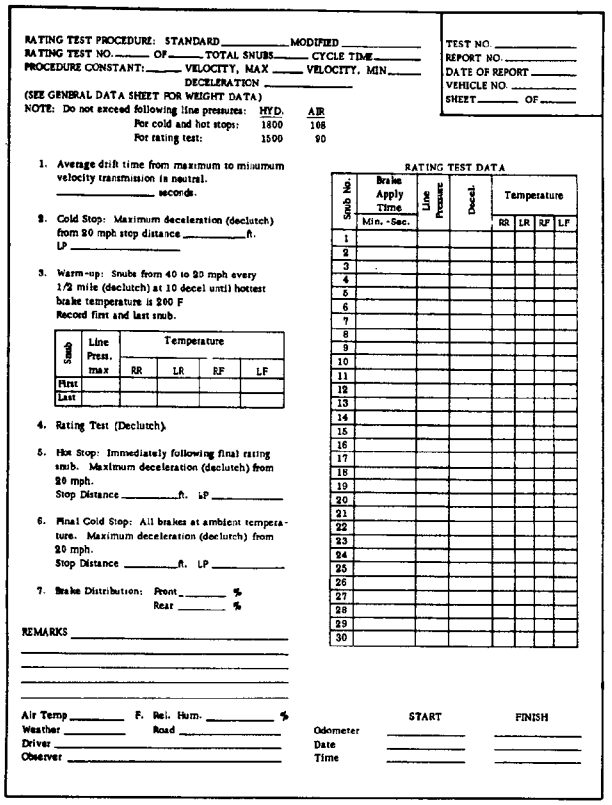
Rad. Cl.
Standout

HYDRAULIC SYSTEM DATA:
Wheel Cyl Size
Type
Power Type _____ Model _____ Dia _____ Stroke _____
Master Cyl _____ Dia _____ Stroke _____
Pedal Ratio _____ Pedal Travel, Max _____ Input Press at Boost Run-Out _____

AIR SYSTEM DATA:
Chamber Type and Area
Level Arm Length
Cam Radius or Wedge Ratio
Air Compressor Size _____ Total Reservoir Capacity _____
Rear Valve _____ Application Valve _____ Front Valve _____

(a) E - Empty

Fig. 1 - General data sheet



RATING TEST PROCEDURE: STANDARD _____ MODIFIED _____
RATING TEST NO. _____ OF _____ TOTAL SNUBS _____ CYCLE TIME _____
PROCEDURE CONSTANT: _____ VELOCITY, MAX _____ VELOCITY, MIN _____
DECELERATION _____
(SEE GENERAL DATA SHEET FOR WEIGHT DATA)
NOTE: Do not exceed following line pressures: HYD. AIR
For cold and hot stops: 1800 108
For rating test: 1500 90

TEST NO. _____
REPORT NO. _____
DATE OF REPORT _____
VEHICLE NO. _____
SHEET _____ OF _____

1. Average drift time from maximum to minimum velocity transmission in neutral. _____ seconds.
2. Cold Stop: Maximum deceleration (declutch) from 20 mph stop distance _____ ft. LP _____
3. Warm-up: Snubs from 40 to 20 mph every 1/2 mile (declutch) at 10 decel until hottest brake temperature is 200 F. Record first and last snub.

Snub	Line Press. max	Temperature RR	LR	RF	LF
First					
Last					

4. Rating Test (Declutch).
5. Hot Stop: Immediately following final rating snub. Maximum deceleration (declutch) from 20 mph. Stop Distance _____ ft. LP _____
6. Final Cold Stop: All brakes at ambient temperature. Maximum deceleration (declutch) from 20 mph. Stop Distance _____ ft. LP _____
7. Brake Distribution: Front _____ % Rear _____ %

REMARKS _____

RATING TEST DATA

Snub No.	Brake Apply Time Min. -Sec.	Line Pressure	Decel.	Temperature RR	LR	RF	LF
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

Air Temp _____ F. Rel. Hum. _____ %
Weather _____ Road _____
Driver _____
Observer _____

Odometer START _____ FINISH _____
Date _____
Time _____

Fig. 2 - Brake rating test data sheet

NOTE: If sufficient engine hp is not available to obtain some evidence of brake fade then vehicle weight or deceleration rate correction must be made in accordance with paragraph 5.2.

4.2 Be equipped with the largest production engine available for the chassis being tested.

4.3 Have new or relatively new tires.

4.4 Have sufficient brake balance to obtain not less than 12 fpsps deceleration (U-tube decelerometer) without locking any wheel. (Brakes to be adjusted to manufacturer's specification.)

4.5 Have a maximum reservoir pressure not exceeding 120 psi for vehicles with air brakes, or a line pressure of 1800 psi for vehicles with hydraulic or air over hydraulic brakes.

4.6 Have new or relatively new production linings burnished as follows:

Make at least 200 brake applications at 40-20 mph at 10 fpsps deceleration, except the 10th snub and every 10th snub thereafter (10th, 20th, 30th, and so on) shall be 50-15 mph at not less than 12 fpsps. All snubs shall be made at one mile intervals with clutch disengaged or automatic transmission in neutral. The vehicle shall be driven at 40 mph between brake applications. Immediately following the 200th application, make 10 applications at two minute intervals, 50-15 mph at not less than 12 fpsps. Record temperatures midpoint between end and commencement of cycle. (If the vehicle is geared to less than 50 mph, operate at top speed with correction as per paragraph 5.2.)

Table 1 - Suggested Number of Snubs for Rating Test

gvw, lb	1st	2nd	3rd
5,000	18	20	24
6,000	17	19	21
7,000	15	17	19
8,000	15	16	17
9,000	14	15	16
10,000	13	14	15
12,500	12	13	14
15,000	11	12	13
20,000	9	10	11
25,000	8	9	10
30,000	7	8	9
40,000	7	8	9

5. RATING PROCEDURE

5.1 SINGLE UNIT VEHICLES -

5.1.1 General - This procedure requires three or more rating tests to determine the maximum number of snubs the brake system can make in 12 minutes without departing from specified deceleration and stopping distance requirements. The first rating test is run using a number of brake snubs less than the maximum of which the brakes are capable. In each succeeding test the number of snubs is increased until the procedure criteria has been reached as outlined in item 5.1.3. Once the maximum number of snubs has been established, a horsepower rating can be calculated using the kinetic energy formula in paragraph 5.1.4.

For the first test, select from Table 1 the approximate number of snubs for the gvw of the vehicle being tested. Snubs should be made in accordance with the brake apply time shown in Table 2, thus continually compensating for fractions of seconds. Continue with the second and subsequent tests, each increasing in severity as required for proper brake rating.

5.1.2 Testing - Actual testing is to be conducted with vehicle declutched or the automatic transmission in neutral.

5.1.2.1 Cold Stop - Make a stop from 20 mph at maximum attainable deceleration. (The maximum service line pressure used should not exceed 108 psi for vehicles with air brakes, or 1800 psi for vehicles with hydraulic brakes.) Maximum initial drum temperature not to exceed 200 F. Record stopping distance and line pressure on Brake Rating Test Data Sheet (Fig. 2.)

5.1.2.2 Warm Up - Make a series of brake snubs from 40 to 20 mph at 10 fpsps deceleration at one-half mile inter-

Table 2 - Brake Apply Time Schedule for Various Total Number of Rating Test Brake Snubs*

Snub No.	Total No. of Brake Snubs (Cycle Time, Sec)														
	7 (103)	8 (90)	9 (80)	10 (72)	11 (65.5)	12 (60)	13 (55.5)	14 (51.5)	15 (48)	16 (45)	18 (40)	20 (36)	24 (30)	26 (27.7)	30 (24)
1	1-38	1-25	1-15	1-07	1- 0.5	0-55	0-50.5	0-46.5	0-43	0-40	0-35	0-31	0-25	0-22.7	0-19
2	3-21	2-55	2-35	2-19	2-06	1-55	1-46	1-38	1-38	1-25	1-15	1-07	0-55	0-50.4	0-43
3	5-04	4-25	3-55	3-31	3-11.5	2-55	2-41.5	2-29.5	2-19	2-10	1-55	1-43	1-25	1-18.1	1-07
4	6-47	5-55	5-15	4-43	4-17	3-55	3-37	3-21	3-07	2-55	2-35	2-19	1-55	1-45.8	1-31
5	8-30	7-25	6-35	5-55	5-22.5	4-55	4-32.5	4-12.5	3-55	3-40	3-15	2-55	2-25	2-13.5	1-55
6	10-13	8-55	7-55	7-07	6-28	5-55	5-28	5-04	4-43	4-25	3-55	3-31	2-55	2-41.2	2-19
7	11-56	10-25	9-15	8-19	7-33.5	6-55	6-23.5	5-55.5	5-31	5-10	4-35	4-07	3-25	3-08.9	2-43
8		11-55	10-35	9-31	8-39	7-55	7-19	6-47	6-19	5-55	5-15	4-43	3-55	3-36.6	3-07
9			11-55	10-43	9-44.5	8-55	8-14.5	7-38.5	7-09	6-40	5-55	5-19	4-25	4-04.3	3-31
10				11-55	10-50	9-55	9-10	8-30	7-55	7-25	6-35	5-55	4-55	4-32.0	3-55
11					11-55.5	10-55	10-05.5	9-21.5	8-43	8-10	7-15	6-31	5-25	4-59.7	4-19
12						11-55	11-01	10-13	9-31	8-55	7-55	7-07	5-55	5-27.4	4-43
13							11-56.5	11-04.5	10-19	9-40	8-35	7-43	6-25	5-55.1	5-07
14								11-56	11-07	10-25	9-15	8-19	6-55	6-22.8	5-31
15									11-55	11-10	9-55	8-55	7-25	6-50.5	5-55
16										11-55	10-35	9-31	7-55	7-18.2	6-19
17											11-15	10-07	8-25	7-45.9	6-43
18											11-55	10-43	8-55	8-13.6	7-07
19												11-19	9-25	8-41.3	7-31
20												11-55	9-55	9-09.0	7-55
21													10-25	9-36.7	8-19
22													10-55	10-04.4	8-43
23													11-25	10-32.1	9-07
24													11-55	10-59.8	9-31
25														11-27.5	9-55
26														11-55.2	10-19
27															10-43
28															11-07
29															11-31
30															11-55

*Brake apply time is shown as minutes-seconds elapsed. Time interval includes 5 sec to allow for brake-on time.

vals. Check brake temperatures after each snub. Continue until the maximum brake temperature, after brake release is 200 F. Record temperature and maximum line pressure on first and last snubs.

5.1.2.3 Rating Test - The rating test shall be run immediately after the warm up according to the description which follows.

Bring vehicle to 15 mph. Start the cumulative time indicator (stop watch) and accelerate vehicle to 50 mph as quickly as possible. Make the predetermined number of snubs from 50 to 15 mph attempting to maintain a 12 fpsps deceleration at the proper time cycle. Do not use over 90 psi service line air pressure or 1500 psi hydraulic pressure on any snub. The following data should be recorded after each snub:

(a) Maximum line pressure used.

(b) Maximum and minimum deceleration.

(c) All brake temperatures.

5.1.2.4 Hot Stop - Immediately following the final snub on the rating cycle, make a maximum deceleration stop from 20 mph. Do not exceed the pressures indicated in paragraph 5.1.2.1. Record stopping distance and line pressure used.

5.1.2.5 Drift Time - The average drift time is determined on a level surface by allowing the chassis to coast from initial to final speed with the clutch disengaged or automatic transmission in neutral. This value must be obtained in the same direction with respect to wind encountered during the test.

5.1.3 Performance Requirements - In order to complete the rating test satisfactorily, the vehicle must have:

5.1.3.1 A deceleration of not less than 9 fpsps during the

rating cycle.

5.1.3.2 A cold stop of no more than:

(a) 25 ft if under 10,000 lb.

(b) 35 ft if 2 axles and vehicle weight of 10,000 lb or over.

(c) 40 ft if 3 axles and vehicle weight of 10,000 lb or over.

5.1.3.3 A hot stop of no more than:

(a) 30 ft if under 10,000 lb.

(b) 42 ft if 2 axles of 10,000 lb and over.

(c) 48 ft if 3 axles of 10,000 lb and over.

After the final rating test is completed and the brakes are cooled (200 F max hottest drum) the brakes must give no evidence of pull, grab, or premature lockup during the subsequent operation. If the vehicle has not exceeded any of the above criteria during this test, it is considered to have been satisfactorily tested.

5.1.4 Horsepower Rating Calculation - The horsepower rating of the brake system can be determined from the following formula:

$$\text{Brake Rating HP} = \frac{W(V_1^2 - V_2^2)\ N}{2 \times 32.2 \times 550 \times 720}\left[1 - \frac{T_1}{T_2}\right]$$

where:

W = gvw of the vehicle, lb

V_1 = Initial speed, fps

V_2 = Final speed, fps

N = Number of snubs made in 720 sec

T_1 = Calculated time in seconds that the brakes are applied in a single snub at the speed and deceleration employed in the test

T_2 = Average drift time in seconds when decelerating from V_1 to V_2

The preceding formula for the standard 50-15 mph cycle may be simplified to:

$$BRHP = 1.91 \times 10^{-4} WN\left[1 - \frac{T_1}{T_2}\right]$$

5.2 TRAILERS AND SINGLE UNITS WHICH CANNOT BE MODIFIED TO CONFORMANCE WITH PROCEDURE IN PARAGRAPH 5.1 - The procedure set forth in 5.1 will require modification when evaluating a tractor-trailer combination. In this case, the tractor and trailer brake systems must be evaluated separately. Wherever possible, the tractor should be loaded to its rated gvw and tested as a truck under the procedure in paragraph 5.1. If the tractor cannot be loaded to its rated gvw, a trailer must be used. The same procedure will apply when testing either the tractor or the trailer brakes. In either case, the total weight of the combination is made as nearly equal as practicable to the gvw of the tractor or axle rating(s) of the trailer, whichever is being tested. Sufficient weight must be on the axles to be rated in order to prevent wheel slippage (approximately 0.7 of the axle rating(s).

The total gross combination weight usually will be in excess of that desired for the rating of the brakes on the axle(s) being tested. Whenever this is true, it will be necessary to apply corrections in initial velocity, deceleration, and stopping distances in accordance with axle brake distribution (see paragraphs 5.3.6 or .7):

Corrected initial velocity

$$= V_3 = \sqrt{\frac{2275 \times BD\% \times \text{gvw (or gcw)}}{\text{Total Test Vehicle Weight}} + 225}$$

Corrected deceleration for test

$$= \frac{BD\% \times \text{gvw (or gcw)} \times 600}{\text{Total Test Vehicle Weight} \times V_3}$$

Corrected stopping distance for test

$$= \frac{\text{Maximum stopping distance permitted}}{BD\%}$$

In order to obtain an overall brake horsepower rating for the combination, the ratings of the tractor and the trailer must be combined (see paragraph 5.3.8).

It is extremely important when testing a tractor-trailer combination that the tractor be equipped with the largest available production engine in order to facilitate rating the brakes.

5.3 COMBINING AXLES OR TRACTOR AND/OR TRAILER UNITS TO ESTABLISH AN OVERALL VEHICLE OR COMBINATION BRAKE RATING - When it is impossible to rate a whole vehicle or a tractor and/or trailer combination, it will be necessary to rate the brakes on the individual axles of a vehicle (or the tractor and trailer) separately and combine the ratings. The brake rating of the individual axles of a truck and the individual rating of the tractor or trailer of a combination are calculated according to paragraph 5.1.4.

In order to combine the axle brake ratings of a vehicle or the tractor brake rating and trailer brake rating of a combination vehicle, it is necessary to determine the brake balance by the following method:

5.3.1 After the brake rating cold stop a warmup stop from 40 mph at a deceleration of 10 fpsps shall be made immediately before the brake balance tests. In the case of vehicles with hydraulic brakes, the line pressure required to obtain the 10 fpsps deceleration shall be the line pressure for all brake balance tests. On vehicles with air brakes the test line pressure shall be 60 psi for all brake balance tests.

5.3.2 Employing all brakes with the single or combination vehicle loaded to the rated gvw/gcw, make three snubs from 20 to 10 mph with the line pressure as established above. Record decelerations.