SAE International

SURFACE VEHICLE STANDARD

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Brake System Rating Test Code - Commercial Vehicles

RATIONALE

All of the revisions, updates, and corrections to this RP, although many, are clearly editorial in nature, and do not generate any substantive changes to the methodology and procedures of this RP. Figure 2, which may exhibit a somewhat different appearance, is identical to the previous Figure 2, except for the revisions and corrections required to address the various errors and omissions. The different appearance is due exclusively to the fact that the Figure had to be recreated from scratch, instead of just modifying the existing Figure.

1. SCOPE

This code is intended for commercial vehicles over 4500 kg (10 000 lb) with brake systems having typical service pressure ranges 0 to 14.1 mPa (0 to 2050 psi) hydraulic or 0 to 830 kPa (0 to 130 psi) air and is not directly applicable to vehicles with other systems. Air over hydraulic systems are to be tested as air systems.

1.1 The code provides test procedures and instructions for:

a. Instrumentation and equipment

b. Vehicle preparation

c. Determining brake system energy absorption capacity

d. Calculation of brake rating

1.2 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. For performance requirements, refer to SAE J257.

1.2.1 The code includes provision for those single unit, combination, and special vehicles which cannot be loaded to the manufacturer's gross vehicle weight rating, or cannot be accelerated in the time interval required, or cannot attain the specified 80.5 km/h (50 mph) speed.

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

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/J880_201110

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 J257 Brake Rating Horsepower Requirements—Commercial Vehicles

SAE J843 Brake System Road Test Code—Passenger Car and Light-Duty Truck

SAE J971 Brake Power Rating Test Code—Commercial Vehicle Inertia Dynamometer

SAE J1505 Brake Force Distribution Test Procedure—Trucks and Buses

SAE J2115 Air Brake Performance and Wear Test Code Commercial Vehicle Inertia Dynamometer

3. INSTRUMENTATION AND EQUIPMENT

Each vehicle to be checked must be equipped with:

3.1 A device for measuring deceleration that is accurate to the nearest 0.3 G's (0.3 mpsps or 1.0 fpsps).

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

3.3 A device for measuring the stopping distance of the vehicle to an accuracy within 1 ft from initial movement of the brake pedal until the vehicle has come to rest.

3.4 A calibrated line pressure gage.

3.5 A stop watch or timing device.

3.6 A means of monitoring the lining temperature to within 5 °C (10 °F) at each brake position either simultaneously or sequentially with a temperature range of 0 to 540 °C (0 to 1000 °F). Brake thermocouple installation is to conform to SAE J2115.

3.7 Provision for reservoir pressure control to limit service line pressure to maximum permitted.

3.8 Shutoff valve to permit cutoff of front and/or rear brakes if brake balance (Section 6) or individual axle brake rating (see 8.3) tests are to be run.

4. VEHICLE INFORMATION AND DATA

4.1 Vehicle Information Sheet (Figure 1) to be filled in prior to starting test.

4.2 Brake Rating Test Data Sheet (Figure 2) for use during the tests. It should be noted that the maximum individual brake temperatures are not to be used as 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 aid in analyzing test results.

VEHICLE INFORMATION SHEET

Test No. _____ Required Watts (BRHP) _____ Test Watts (BRHP) _____

Test Facility and Location _____
Vehicle Make and Model _____
Estimated Center of Gravity of Body and Test Load Above Ground _____

Weight Distribution: Front Axle _____ Rear Axle(s) _____ Total _____
Trailer Axle(s) _____
Gross Total _____

Special Conditions Which Might Affect Brake Performance _____

Are Backing Plates or Dustshields Installed? Front _____ Rear _____ Trailer _____

Tire Size: Front _____ Measured Static Rolling Radius: Front _____
Rear _____ Rear _____
Trailer _____ Trailer _____

Type of Wheels: Front _____ Rear _____ Trailer _____
(Cast Steel Spoke, Steel Disc. Alum., Disc, etc.)

Type of Rim: Front _____ Rear _____ Trailer _____
(Flat Base, Drop Center, etc.)

Brake Drum:	Weight	Type	Make	Part No.
Front				
Rear-Forward				
Rear-Rear				
Trailer				

Brakes:	Size	Make	Type	Lining	Assy. No.
Front					
Rear-Forward					
Rear-Rear					
Trailer					

Actuation Details: (Fill Out per Headings for Either Hydraulic or Air Brakes)

If Hydraulic:	Vacuum Booster or Air Chamber Type and Size	Pedal Ratio and Usable Travel	Master Cylinder Dia and Stroke	Wheel Cylinder Dia(s)

If Air:	Air Chamber Type and Size	Slack Adj. Length or Wedge Angle	Cam Radius	Cam Rotation (With or Opp. Drum)
Front				
Rear-Forward				
Rear-Rear				
Trailer				

Adjustment:	Front	Rear-Forward	Rear-Rear	Trailer
(Automatic)				
(Manual)				
Actuator Stroke at 80 psi (552 kPa) (L/R)				

FIGURE 1 - VEHICLE INFORMATION SHEET

BRAKE RATING TEST DATA SHEET

Test No. _____ Data Sheet No. _____ of _____ Date _____

No. of Snubs _____ Brake Rating Power/kW (brhp) _____ Passed _____ Did Not Pass _____

NOTE: Starting Temperature (Hottest Brake) Must be 66-93 °C (150-200 °F) for Conditioning, Cold Stop(s), Drift Time, Rating Test, and Cooled Stop

Drift Time, s: (1) _____ (2) _____ (3) _____

Cold Stop(s) 32.2 km/h 20mph	Start Temp. °C (°F)	Max. Line Pressure MPa (hydraulic) KPa (pneumatic)	Max. Decel. m/s² (ft/s²)	Stop Dist. m (ft)	Wheels Locked or Cycled	Pedal or Actuator Stroke, m (in) L/F	R/F	LR-F	RR-F	LR-R	RR-R
First											
Second											
Third											

Rating Test Initial Speed, km/h (mph) _____ Final Speed, km/h (mph) _____ Cycle Time, s _____

Deceleration, m/s² (ft/s²) Initial _____ Minimum Limit _____

Snub	Brake Apply Time	Press. MPa (hydraulic) KPa (pneumatic)	Decel. m/s² (ft/s²)	Temperature, °C (°F)	Snub	Brake Apply Time	Press. MPa (hydraulic) KPa (pneumatic)	Decel. m/s² (ft/s²)	Temperature, °C (°F)
1					16				
2					17				
3					18				
4					19				
5					20				
6					21				
7					22				
8					23				
9					24				
10					25				
11					26				
12					27				
13					28				
14					29				
15					30				

Hot Stop(s) 32.2 km/h 20 mph	Start Temp. °C (°F)	Max. Line Pressure MPa (hydraulic) KPa (pneumatic)	Max Decel. m/s² (ft/s²)	Stop Dist. m (ft)	Wheel Locked or Cycled	Pedal or Actuator Stroke, m (in) L/F	R/F	LR-F	RR-F	LR-R	RR-R

Stability: Cold Stop _____ Rating Test _____ Hot Stop _____ Cooled Stop _____

Remarks (All deviations from the standard or special procedures, including burnish, must be noted.)

_____

_____

_____

_____

Test Summary	Satisfactory (S)	Unsatisfactory (U)
Cold Stop		
Rating Test		
Hot Stop		
Stability		
Final Inspect.		

Time _____ m Ambient Temp. _____ °C (°F) Road Condition _____

Location _____

Driver _____ Data Recorder _____

FIGURE 2 - BRAKE RAETING TEST DATA SHEET

WORK SHEET—CORRECTION FACTORS
FOR LOADS OTHER THAN THE RATED CAPACITY OF THE AXLE(S) OR VEHICLE(S)

Vehicle: Truck _____ Tractor _____ Full Trailer _____ Semi-Trailer _____
Make _____ Model _____
Calculated by _____ Date _____

Velocity Correction (for Burnish and Rating Test)

Y = _____ Braking Percentage on the Test Axle(s) or Vehicle(s) (From Brake Balance Test).

V_1 = _____ Standard Velocity from Which Retardation Starts When Operated at GVWR km/h (mph).

V_2 = _____ Standard Velocity at Which Brakes are Released, km/h (mph).

W = _____ GVWR of the Vehicle on Test (Trucks, Tractors, and Full Trailers) kg (lb).

W_1 = _____ Rated Load of the Test Axle(s) (Sem-Trailers) kg (lb).

W_2 = _____ Total Weight being Retarded by the Brakes on the Test Axle(s), kg (lb).

V_3 = Corrected Test Velocity, Trucks, Tractors, and Full Trailers = $\sqrt{\frac{Y}{100} \times (V_1^2 - V_2^2 \times \frac{W}{W_2} + V_2^2}$ = _____km/h(mph)

V_3 Corrected Test Velocity Semi-Trailers = $\sqrt{(V_1^2 - V_2^2) \times \frac{W_1}{W_2} + V_2^2}$ = _____km/h(mph)

Deceleration Correction (for Burnish and Rating Test)

d = Standard Deceleration = Burnish | Rating | m/s² (ft/s²)

d_1 = Corrected Deceleration Trucks, Tractors, and Full Trailers = $\frac{Y}{100} \times \frac{(V_1 \times d)}{V_3} \times \frac{W}{W_2}$ = | | | m/s² (ft/s²)

d_1 = Corrected Deceleration Semi-Trailers = $\frac{(V_1 \times d)}{V_3} \times \frac{W_1}{W_2}$ = | | | m/s² (ft/s²)

Standard Stopping Distance Correction

S = Maximum Standard Stopping Distance = | Cold m(ft) | Hot m(ft)

S_1 Corrected Maximum Standard Stopping Distance—Trucks, Tractors, Full Trailers $\frac{100}{Y} \times \frac{W_2}{W} \times S$ = | m(ft) | m(ft)

S_1 Corrected Maximum Standard Stopping Distance—Semi-Trailers $\frac{W_1}{W_1} \times S$ = | m(ft) | m(ft)

FIGURE 3 - WORK SHEET - CORRECTION FACTORS (FOR LOADS) OTHER THAN RATED CAPACITY OF AXLE(S) OR VEHICLE(S)

4.3 Work Sheet

Correction Factors (Figure 3) to be filled out and used as required per 8.2.

5. VEHICLE CONDITION

To rate the brake system properly, the vehicle should:

5.1 Be loaded to GVWR except as provided for in 8.3. The weight must be distributed as closely as possible to load each axle to its rated load GAWR. 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.

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

NOTE: If sufficient engine horsepower is not available to obtain some evidence of brake fade, then vehicle weight or deceleration rate correction must be made in accordance with 8.2.

5.3 Have new or relatively new tires inflated to the cold pressures specified for maximum tire load rating.

5.4 Have sufficient brake balance to obtain not less than 3.7 mpsps (12 fpsps) steady-state deceleration without locking any wheel or causing any wheel slip brake control system to cycle. (Brakes are to be adjusted to manufacturer's specifications.)

5.5 All vehicles are to be equipped with unmodified brake actuation systems (pressure proportioning valves, metering valves, and wheel slip brake control systems are to be functional as installed in production vehicle) except for test equipment specified in 3.7 and 3.8.

5.6 Be equipped with new unburnished production linings which shall then be burnished as follows:

Make 500 brake snubs from 64 to 32 km/h (40 to 20 mph) with a deceleration of 3 mpsps (10 fpsps) at 1.6 km (1 mile) intervals. Except where an adjustment is specified, after each application accelerate to and maintain 64 km/h until making the next brake application at a point 1.6 km (1 mile) from the initial point of the previous brake application. If the vehicle can not attain a speed of 64 km/h (40 mph) in 1.6 km (1 mile), continue to accelerate until the vehicle reaches 64 km/h (40 mph) or until the vehicle has traveled 2.4 km (1.5 miles) from the initial point of the previous application, whichever occurs first.

The brakes may be adjusted up to three times (after 125, 250, and 375 snubs) in accordance with the manufacturer's recommendations and shall be adjusted after completion of the burnish according to the manufacturer's recommendations.

Use velocity and deceleration corrections when required for axle-by-axle or vehicle-by-vehicle tests of combinations. Drive as nearly as possible at the uncorrected indicated velocity between snubs, drifting to the proper corrected velocity before each snub.

6. BRAKE BALANCE TEST

This test is optional, and must be run prior to the start of the rating procedure when axle-by-axle or vehicle-by-vehicle ratings are to be combined in accordance with 8.3. In addition, this procedure may be used optionally to provide useful information concerning the distribution of total braking effort among axles and/or vehicles. Such information can be of great use in adjusting brake inputs to achieve a desired proportioning of braking effectiveness among the axle and/or vehicle; but, no changes in the brakes or actuation system may be made at this point to improve brake balance unless new linings are installed and burnished before going to the rating procedure (Section 7). The Brake Force Distribution Test Code—Commercial Vehicles—SAE J1505 is to be followed to determine brake balance.

7. RATING PROCEDURE

7.1 General

7.1.1 It is recommended that brakes be re-adjusted to the manufacturer's specifications after burnish.

7.1.2 A series of three rating tests must be run before a rating can be established. The first two tests are run at reduced energy input levels to condition the lining material and to familiarize the driver and observer with the test procedure prior to the qualifying test(s).

7.1.3 Starting temperature (hottest brake) must be 66 to 93 °C (150 to 200 °F); 1.02 mm ± 0.13 mm (0.040 in ± 0.005 in) for conditioning prior to drift time, cold stop(s), rating tests, and cooled stop. It is recommended that the depth of the thermocouple recess be maintained at 1.02 mm ± 0.13 mm (0.040 in ± 0.005 in) prior to each test.

7.1.4 All brake applications in the following Test Sequence shall be made with the transmission in neutral or the clutch disengaged.

7.1.5 Record all data on Brake Rating Test Data Sheet (Figure 2).

7.2 Test Sequence

7.2.1 Temperature Conditioning

Whenever temperature conditioning of the vehicle is required (for example; prior to the first test of the day), it shall consist of a series of snubs from 80.5 to 24 km/h (50 to 15 mph) at 3.7 mpsps (12 fpsps) at 3.2 km (2 mile) intervals (using corrected velocities and decelerations where applicable) until the 66 to 93 °C (150 to 200 °F) temperature range for hottest brake is attained.

7.2.2 Drift Time

The drift time shall be determined immediately following temperature conditioning (at 66 to 93 °C (150 to 200 °F) hottest brake). The average drift time is determined by letting the vehicle coast (transmission in neutral) from 80.5 km/h (50 mph), or as corrected, to 24 km/h (15 mph). This value must be obtained in the same direction or directions with respect to the wind encountered during the test.

7.2.3 Cold Stop

Make three stops from 32.2 km/h (20 mph) at sufficient deceleration to meet the cold stop distance requirement. The maximum service line pressure used shall not exceed 690 kPa (100 psi) for vehicles with air brakes or 12.0 mPa (1750 psi) for vehicles with hydraulic brakes.

7.2.4 Rating Tests

For rating purposes, a test series of three to five rating test cycles are permitted on a specific set of linings. The objective is to determine the maximum number of snubs from 80.5 km/h (50 mph) to 24.1 km/h (15 mph) that can be performed in a 12 min time frame without departing from the specified deceleration and maximum pressure requirements.

For the first rating test, begin by making 12 snubs. If the requirements are met, increase the number of snubs by one or two based on the performance margin of the previous cycle. If it fails, reduce the number of snubs by one. Once the maximum number of snubs that can be completed within the required time without departing from the deceleration or pressure requirements has been established, the power rating can be calculated based on that test and the number of snubs completed using the equation in 7.4.

Snubs should be made in accordance with the brake apply time shown in Table 1, thus continually compensating for fractions of seconds. Continue with the second and subsequent tests, each increasing in severity as required for proper rating.

TABLE 1 - BRAKE APPLY TIME SCHEDULE FOR VARIOUS TOTAL NUMBER OF RATING TEST BRAKE SNUBS[1]

Snub No.	TOTAL NUMBER OF BRAKE SNUBS (CYCLE TIME, S)																					
	8 (90)	9 (80)	10 (72)	11 (66)	12 (60)	13 (56)	14 (52)	15 (48)	16 (45)	17 (42)	18 (40)	19 (38)	20 (36)	21 (34)	22 (33)							
1	1 to 25	1 to 15	1 to 07	1 to 01	0 to 55	0 to 51	0 to 47	0 to 43	0 to 40	0 to 37	0 to 35	0 to 33	0 to 31	0 to 29	0 to 28							
2	2 to 55	2 to 35	2 to 19	2 to 06	1 to 55	1 to 46	1 to 38	1 to 31	1 to 25	1 to 20	1 to 15	1 to 11	1 to 07	1 to 40	1 to 01							
3	4 to 25	3 to 55	3 to 31	3 to 12	2 to 55	2 to 42	2 to 30	2 to 19	2 to 10	2 to 02	1 to 55	1 to 49	1 to 43	1 to 38	1 to 33							
4	5 to 55	5 to 15	4 to 43	4 to 17	3 to 55	3 to 37	3 to 21	3 to 07	2 to 55	2 to 45	2 to 35	2 to 27	2 to 19	2 to 12	2 to 06							
5	7 to 25	6 to 35	5 to 55	5 to 23	4 to 55	4 to 33	4 to 13	3 to 55	3 to 40	3 to 27	3 to 15	3 to 04	2 to 55	2 to 46	2 to 39							
6	8 to 55	7 to 55	7 to 07	6 to 28	5 to 55	5 to 28	5 to 04	4 to 43	4 to 25	4 to 09	3 to 55	3 to 42	3 to 31	3 to 21	3 to 11							
7	10 to 25	9 to 15	8 to 19	7 to 34	6 to 55	6 to 24	5 to 56	5 to 31	5 to 10	4 to 52	4 to 35	4 to 20	4 to 07	3 to 55	3 to 44							
8	11 to 55	10 to 35	9 to 31	8 to 39	7 to 55	7 to 19	6 to 47	6 to 19	5 to 55	5 to 34	5 to 15	4 to 58	4 to 43	4 to 29	4 to 17							
9		11 to 55	10 to 43	9 to 45	8 to 55	8 to 15	7 to 39	7 to 07	6 to 40	6 to 16	5 to 55	5 to 36	5 to 19	5 to 04	4 to 50							
10			11 to 55	10 to 50	9 to 55	9 to 10	8 to 30	7 to 55	7 to 25	6 to 59	6 to 35	6 to 14	5 to 55	5 to 38	5 to 22							
11				11 to 56	10 to 55	10 to 06	9 to 22	8 to 43	8 to 10	7 to 41	7 to 15	6 to 52	6 to 31	6 to 12	5 to 55							
12					11 to 55	11 to 01	10 to 13	9 to 51	8 to 55	8 to 23	7 to 55	7 to 30	7 to 07	6 to 46	6 to 28							
13						11 to 57	11 to 05	10 to 19	9 to 40	9 to 06	8 to 35	8 to 08	7 to 43	7 to 21	7 to 01							
14							11 to 56	11 to 07	10 to 25	9 to 48	9 to 15	8 to 45	8 to 19	7 to 55	7 to 33							
15								11 to 55	11 to 10	10 to 30	9 to 55	9 to 23	8 to 55	8 to 29	8 to 06							
16									11 to 55	11 to 13	10 to 35	10 to 11	9 to 31	9 to 04	8 to 39							
17										11 to 55	11 to 15	10 to 39	10 to 07	9 to 38	9 to 11							
18											11 to 55	11 to 17	10 to 43	10 to 12	9 to 44							
19												11 to 55	11 to 19	10 to 46	10 to 17							
20													11 to 55	11 to 21	10 to 49							
21														11 to 55	1 to 22							
22															11 to 55							

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

To start the rating test, bring the vehicle to 24.1 km/h (15 mph). Start the stop watch and accelerate the vehicle to 80.5 km/h (50 mph) or to the corrected velocity as soon as possible. Make the predetermined number of snubs from 80.5 km/h (50 mph) to 24 km/h (15 mph) at the proper time cycle attempting to maintain a deceleration of 3.6 mpsps (12 fpsps) by varying the input pressure up to a maximum of 690 kPa (100 psi) service line air pressure or 12.0 mPa (1750 psi) hydraulic pressure on any snub.

7.2.5 Hot Stop

Immediately following the final snub of the rating test, accelerate to 32.2 km/h (20 mph) and make a stop at sufficient deceleration to meet the hot stop distance requirement. The maximum service line pressure used shall not exceed 690 kPa (100 psi) for vehicles with air brakes or 12.0 MPa (1750 psi) for vehicles with hydraulic brakes.

7.2.6 Cooled Stop

Cool the brakes to 93 °C (200 °F) maximum (hottest brake) and make a stop from 32.2 km/h (20 mph) without locking any wheel or cycling any wheel slip brake control system at a deceleration of 2.7 to 3.7 mpsps (9 to 12 fpsps) to determine final brake stability.

7.2.7 Final Inspection

Remove drums and visually inspect brakes for functional and structural integrity.

7.3 Rating Requirements

In order to complete the rating test satisfactorily, the vehicle brake system must comply with the following:

7.3.1 Cold stop if no more than:

a. 10.7 m (35 ft) if single-unit vehicle

b. 12.2 m (40 ft) if combination vehicle

7.3.2 An initial deceleration of 3.7 mpsps (12 fpsps) with deceleration in subsequent snubs of not less than 2.7 mpsps (9 fpsps) during the rating test.

7.3.3 Hot stop of no more than:

a. 12.8 m (42 ft) if single-unit vehicle

b. 14.6 m (48 ft) if combination vehicle

7.3.4 Stability such as to remain in a 3.7 m (12 ft) lane during any brake application throughout all phases of the test procedure.

7.3.5 Final inspection showing no visual evidence of permanent deficiency in functional or structural integrity of the parts.

7.4 Power Rating Calculation

The power rating of the brake system formula is shown in Equations 1 and 2:

$$\text{BRP (Watts)} = \frac{W(V_1^2 - V_2^2)N}{0.0007322 \times 2 \times 32.2 \times 550 \times 720}\left[1 - \frac{T_1}{T_2}\right]$$

$$\text{BRP (Watts)} = 5.35 \times 10^{-5} \times W(V_1^2 - V_2^2)N\left[1 - \frac{T_1}{T_2}\right] \quad \text{(Eq. 1)}$$

$$\text{Brake Rating HP (lb.mph)} = \frac{W(V_1^2 - V_2^2)N}{0.465 \times 2 \times 32.2 \times 550 \times 720}\left[1 - \frac{T_1}{T_2}\right]$$

$$\text{BRHP} = 8.43 \times 10^{-8} \times W(V_1^2 - V_2^2)N\left[1 - \frac{T_1}{T_2}\right] \quad \text{(Eq. 2)}$$

where:

W = GVWR of the vehicle, kg (lb)
V_1 = Standard velocity (initial), km/h (mph)
V_2 = Standard velocity (final), km/h (mph)
N = Number of snubs made in 720 s
T_1 = Calculated time(s) that the brakes are applied in a single snub at the velocity and deceleration employed in the test

or $T_1 = \frac{(V_1 - V_2)}{d}$

(Substitute V_3 for V_1 and/or d_1 for d per 8.2 when running tests with corrected velocity and/or deceleration.)
d = Standard deceleration for either burnish or rating tests, m/s^2 (ft/s^2)
T_2 = Average drive time(s) when decelerating from V_1 to V_2 (or V_3 to V_2 when running tests with corrected velocity per 8.2.)
0.465 = Constant to accommodate velocity in km/h, weight in kg, and power in watts in the formula.

For the standard procedure, 80.5 to 24.1 km/h (50 to 15 mph) snub, Equation 2 simplifies to Equation 3:

$$\text{BRP (Watts)} = 3.12 \times 10^{-4} WN\left[1 - \frac{T_1}{T_2}\right]$$

$$\text{BRHP} = 1.91 \times 10^{-4} WN\left[1 - \frac{T_1}{T_2}\right] \quad \text{(Eq. 3)}$$

8. SPECIAL PROCEDURES

8.1 Formula Snub Ratings

8.1.1 Steps in Test Planning

8.1.1.1 If unable to rate at N snubs, but still satisfactory at (N – 1) snubs, it may be possible to rate by change in procedure to obtain only a required minimum brake rating power.

8.1.1.2 Selecting final velocity at higher values than 24.1 km/h (15 mph) lends more accuracy in test than changing initial velocity.

8.1.1.3 Let V_4 equal velocity in km/h (mph) to be calculated from minimum required brake rating power. See Equation 4.

$$V_4 = \sqrt{V_1^2 - \frac{\text{Min Required BRP (Watts)}}{(5.35 \times 10^{-5})WN\left[1 - \frac{T_1}{T_2}\right]}}$$

$$V_4 = \sqrt{V_1^2 - \frac{\text{Min Required BRHP}}{(8.43 \times 10^{-8})WN\left[1 - \frac{T_1}{T_2}\right]}} \quad \text{(Eq. 4)}$$