



Brake Equilibrium Temperature and Brake Cooling

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purposes of this test are to measure brake temperatures resulting from multiple brake applies and to measure the ability of the brake to cool after thermal input.

1.2 Foreword. The Brake Equilibrium Temperature (BET) test was developed based on SAE International Recommended Practice J1247 (SAE J1247) section 5.5 First Simulated Mountain section. The test establishes the brake rotor or drum temperature when the thermal input from the brake snubs approximately equals the brake cooling during the interval between the snubs; thus, the brake equilibrium temperature. This brake equilibrium temperature simulates brake temperature performance under mountain driving conditions. Requirements for BET can drive brake rotor or brake drum sizing and geometry for a vehicle platform.

The Cooling Coefficient (CC) test measures the ability of the brake rotor or brake drum to cool. The test measures the temperature decay during constant air flow conditions. The cooling is measured at several vehicle speeds to establish a cooling versus speed profile.

The optional High Temperature CC test was developed to accommodate vehicles with high speed braking usage.

1.3 Applicability. This procedure is applicable to all passenger cars, multi-purpose vehicles and light trucks.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

FMVSS 135 SAE J1247

2.2 GM Standards/Specifications.

GMW14974 GMW15102

3 Resources

3.1 Facilities.

3.1.1 Vehicle weighing station providing measurements of at least the front and rear axle; ballast material.

3.1.2 A circular test road is preferred to minimize steering input variation. An oval test track may be used. The road surface must be a smooth, hard-surface.

3.2 Equipment.

3.2.1 Brake lining thermocouples should be used per FMVSS 135 at all brake corners.

3.2.2 Brake rotor/drum thermocouples should be used per GMW14974. Vented rotors require thermocouples on the inboard and outboard cheeks. Solid rotors and drums require one thermocouple. Insert additional thermocouples if requested. Slip rings will be required.

3.2.3 Brake fluid temperature thermocouples at brake corner bleed valve.

3.2.4 Ambient temperature thermocouple.

3.2.5 Decelerometer.

3.2.6 Vehicle speed measurement equipment.

3.2.7 Service brake pedal force transducer.

3.2.8 Electronic timer or stop watch.

3.2.9 A data acquisition system capable of recording multiple temperature channels and any other requested channels.

3.2.10 Pedal travel transducer and booster vacuum transducer will be required for the brake system floor check. These data are not required during the BET or cooling tests.

3.2.11 Additional instrumentation may be requested. If torque wheels are installed, the test results will reflect the cooling of the torque wheel vent area. This vent area might be very different from that of the production wheels and may affect the interpretation of the results.

3.2.12 All instrumentation is to be calibrated as required. List instrumentation identification and calibration dates in the test record unless otherwise preserved by the test laboratory.

3.3 Test Vehicle/Test Materials.

3.3.1 Vehicle.

3.3.1.1 Test vehicle should be representative of the vehicle family with respect to body type, tire/wheel size.

3.3.1.2 Trim height, front fascia design, wheel vent area, rotor splash shields, and backing plates should be as specified by request engineer. Brake cooling enhancements (ducts, fins, etc.), if any, should be as specified by requesting engineer.

3.3.2 Materials. New brake pads/linings and rotors/drums are recommended but not required. However, brake parts should be in burnished condition at start of test. The default brake burnish for new parts is the FMVSS 135 brake burnish. Follow instructions in the test request.

3.4 Test Time. Timing below assumes one test and dry weather.

Calendar time: 3 to 4 days (with vehicle)

Test hours: 6 to 8 hours (track time not including 8 hours brake burnish)

Coordination hours: 4 hours (analysis)

3.5 Test Required Information. The brake equilibrium temperature and CC test may be run as a stand-alone test or within a series of brake thermal tests, or as a study of cooling with changes to vehicle components that effect air flow at the brake corners. One (1) set of hardware may be used for two tests on the same vehicle, unless wear-out or a change in brake balance necessitates a hardware change for each test.

3.6 Personnel/Skills. An experienced, trained brake technician capable of vehicle setup and performing the instructions in Section 4.

4 Procedure

4.1 Preparation.

4.1.1 Document basic information about vehicle and brake system in the test record.

4.1.2 Thermocouple all brake rotors and/or drums. Thermocouple all brake pads and/or linings.

4.1.3 Install instrumented brake components.

4.1.4 Place the ambient temperature thermocouple inside a containing tube. The tube shall be mounted on the outside of the vehicle exposed to free stream air. Recommended mounting position is on the right front quarter panel.

4.1.5 Install the specified wheels and tires, and wheel covers (if applicable), and slip rings. If running the optional high speed CC test, to minimize slip ring vibration, balance all tire/wheel units and mount slip rings as close to the wheel as possible by using the shortest mounting stand-offs available for the hub.

4.1.6 Perform a brake system floor check before breaking into the brake hydraulic system to install the brake fluid thermocouples. Install the fluid thermocouples in the brake bleeder valves unless otherwise instructed.

4.1.7 Complete installation of instrumentation and data acquisition system. Make certain that driver can monitor vehicle speed, deceleration and brake temperatures as needed.

4.1.8 Ballast the vehicle to the gross vehicle weight rating (GVWR) loading condition as defined in paragraph 7.1. Record the weight and weight distribution.

4.1.9 Adjust tire pressure to recommended level for loaded vehicle.

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4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Road surface must be dry.

4.2.1.2 Sustained wind speed must be less than 16 km/h. Wind gusts must be less than 32 km/h.

4.2.1.3 Testing shall be restricted to an ambient temperature range of -6 to 35 °C.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Brake system thermal performance is influenced by many factors including: vehicle loading condition, vehicle braking fraction, ambient temperature, wind conditions, cooling air flow, rotor volume, rotor surface area, and rotor material properties. The rotor characteristics and air flow to the brakes are determined by the vehicle design. The other factors should be controlled as much as possible by running the brake thermal tests under restricted conditions. Controlling these factors permits vehicle-to-vehicle and test-to-test comparisons.

4.2.2.2 CCs are generally measured at several test speeds. Test speeds at or above 50 km/h are recommended. Tests run at speeds lower than 50 km/h are less repeatable. The recommended test speeds are 50 km/h, 80 km/h, and 110 km/h.

4.2.2.3 Dry road surfaces are required. Moisture spray will affect the rate of cooling.

4.2.2.4 Restrictions on wind velocity are stated in the environmental conditions section. Wind gusts will decrease the correlation between theoretical and actual temperatures.

4.2.2.5 Brake drag can be indicated using the stabilization temperatures.

4.2.2.6 All vehicle doors and windows should be closed. Exceptions required for instrumentation or ventilation should be noted in the test record.

4.2.2.7 Brake Equilibrium Temperature test drive time is up to 30 minutes continuous. Schedule cannot be interrupted. Do not start test without sufficient time or fuel.

4.2.2.8 CC test drive time is 30 to 45 minutes continuous. Test cannot be interrupted. Do not start test without sufficient time or fuel.

4.2.2.9 An optional high temperature rotor CC test is included in this procedure. This high temperature test should be restricted to high performance vehicles and specialty vehicles, such as police vehicles.

4.3 Instructions.

4.3.1 Record ambient weather conditions at time of testing, including ambient temperature, wind velocity, humidity, and barometric pressure.

4.3.2 If a brake burnish is requested, unless instructed otherwise, perform the 200 stop brake burnish specified in FMVSS 135. Use pad temperatures.

4.3.3 The suggested test schedule is shown in Table 1. The Brake Equilibrium Temperature test is defined in paragraph 4.3.4. The CC test is defined in paragraph 4.3.5. The Optional High Temperature Rotor Cooling test is defined in paragraph 4.3.6. Note modifications to this schedule in the test record.

Table 1: Test Schedule

Test	Data Scan Rate
1 st Brake Equilibrium Temperature	5 Hz
1 st 110 km/h Cooling Coefficient	5 Hz
2 nd Brake Equilibrium Temperature	5 Hz
2 nd 110 km/h Cooling Coefficient	5 Hz
1 st 50 km/h Cooling Coefficient	5 Hz
2 nd 50 km/h Cooling Coefficient	5 Hz
1 st 80 km/h Cooling Coefficient	5 Hz
2 nd 80 km/h Cooling Coefficient	5 Hz
Optional High Temperature Cooling Coefficient (Restricted use.)	5 Hz

4.3.4 Brake Equilibrium Temperature Test.

4.3.4.1 All snubs during the BET schedule are to be made with vehicle transmission in highest driving gear. For manual transmission vehicles, do not downshift during snub. Disengage clutch to prevent engine stall as needed.

4.3.4.2 Drive vehicle at test speed until the initial brake temperatures (IBT) of all pads and rotors are less than 65 °C. If brake drag is apparent from temperature data, return to garage area and check brake components for correct function and installation before continuing test.

4.3.4.3 Check data acquisition system. Record data from all equipment listed in paragraph 3.2. Set scan rate to 5 Hz. Activate data acquisition. Perform Brake Equilibrium Temperature test as shown in Table 2. The 20 s time interval is from start-of-snub to start-of-snub and includes the acceleration time. Hold vehicle at initial speed until the time interval is complete. For vehicles with a GVWR greater than 3500 kg, use a 30 s time brake snub interval as shown in Table 3.

Table 2: Brake Equilibrium Temperature Schedule

Number of Snubs	80
Deceleration	0.25G
Initial Speed	64 km/h
Final Speed	24 km/h
Acceleration	0.13G
Time Interval	20 s

Table 3: Brake Equilibrium Temperature Schedule for Vehicles with GVWR greater than 3500 kg

Number of Snubs	80
Deceleration	0.25G
Initial Speed	64 km/h
Final Speed	24 km/h
Acceleration	0.13G
Time Interval	30 s

4.3.4.4 If drive schedule is interrupted, abort the test and start again. Abort the test if high brake temperatures degrade the brake output to the point that the drive schedule cannot be maintained.

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