

**Brake Test Procedure and  
Brake Performance Criteria  
for Agricultural Equipment –  
SAE J1041 MAR83**

SAE Recommended Practice  
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# BRAKE TEST PROCEDURE AND BRAKE PERFORMANCE CRITERIA FOR AGRICULTURAL EQUIPMENT—SAE J1041 MAR83

## SAE Recommended Practice

Report of the Tractor Technical Committee, approved September 1973, last revised by the Agricultural Tractor Technical Committee March 1983. Conforms to ASAE S-365. Rationale statement available.

1. **Purpose**—The purpose of this SAE Recommended Practice is to establish test procedures for measurement of brake system performance and minimum performance criteria for agricultural equipment equipped with brakes.

2. **Scope**—The test procedures and performance criteria are directed to the travel, parking, and towing of agricultural equipment that may be operated on a highway.

### 3. Definitions

3.1 **Agricultural Equipment**—Agricultural tractors, agricultural self-propelled material transporter, self-propelled implements, and combinations of tractors or self-propelled implements with trailed equipment designed primarily for use in agricultural operations.

3.2 **Agricultural Self-Propelled Material Transporter**—A single unit agricultural self-propelled machine designed to haul agricultural material, but which may also be used to push or tow agricultural equipment.

3.3 **Agricultural Tractor**—As defined in SAE J1150 (ASAE S-390).

3.4 **Brake System Input Force**—This force is the sum of all forces applied by the operator to the brake system, as measured at the normal point of load application, in a line from the point of application through the operator's hip joint for foot-pedal controls, or through the operator's arm-to-shoulder joint for hand-operated controls.

3.5 **Combination Machine**—A self-propelled machine coupled to trailed equipment, where at least one unit is equipped with brakes.

3.6 **Secondary Brake System**—A brake system used for stopping a machine in the event of a malfunction in the operation and control of the service brake system.

3.7 **Highway**—As defined in SAE J137 (ASAE S-279).

3.8 **Maximum Machine Weight**—The weight of the test machine conforming with the manufacturer's recommendations, when it is fully laden, when it is fully ballasted, or when it is equipped with either permanently mounted, semipermanently mounted, or quickly detachable auxiliary equipment.

3.9 **Parking Brake System**—A means for holding a machine continuously in a parked position.

3.10 **Self-Propelled Agricultural Implement**—A machine designed to perform an agricultural operation without the use of a separate propelling machine.

3.11 **Service Brake System**—The primary system used for retarding and stopping a machine.

3.12 **Single Unit Machine**—A self-propelled machine not coupled to trailed equipment.

3.13 **Stopping Distance**—The distance traveled between the point at which the brake control is actuated, and the point at which the machine comes to a stop.

3.14 **Stopping Time**—The time elapsed between the instant at which the brake control is actuated and the instant at which the machine comes to a stop.

3.15 **Test Machines**—The term used in this recommendation for agricultural equipment on which brake performance tests are conducted.

3.16 **Trailled Equipment**—Single or multiple implements or equipment trailed or semimounted to a propelling machine.

4. **Classifications**—For the purpose of this recommendation, agricultural equipment is classified as follows:

**Class A**—Agricultural tractor and agricultural self-propelled material transporter. Examples: agricultural tractor, self-propelled bale wagon, self-propelled forage wagon.

**Class B**—Self-propelled equipment or combinations of trailed equipment coupled to a Class A machine primarily used for field work. Examples: self-propelled combines, self-propelled swathers, self-propelled cultivators, self-propelled balers, self-propelled forage harvesters, tractors coupled to trailed equipment.

**Class C**—Combination of trailed agricultural equipment coupled to a Class A machine primarily used for haulage. Examples: tractors with

farm wagons, fertilizer distributors, nurse tank wagons, all other implements and combinations of agricultural equipment.

### 5. Facilities and Instrumentation

5.1 **Ambient Temperature**—A means to measure ambient temperature within  $\pm 5^\circ\text{F}$  ( $\pm 3^\circ\text{C}$ ).

5.2 **Brake Temperature**—A temperature measuring system shall have  $\pm 2\%$  full-scale accuracy (optional instrumentation).

5.3 **Braking System Input Force**—An instrument to measure the applied force to the brake control, within an accuracy of  $\pm 3\%$ .

5.4 **Deceleration**—An instrument to measure maximum deceleration within an accuracy of  $\pm 3\%$  (optional instrumentation).

5.5 **Stopping Distance**—A means to measure the stopping distance within an accuracy of  $\pm 1\%$ .

5.6 **Test Course**—The test course shall be straight and consist of a clean swept, level dry concrete, or other specified surface of adequate length to conduct the test. The approach will be of sufficient length, smoothness, and uniformity of grade to assure stabilized travel speed of the machine. The braking surface shall not have over 1% slope in the direction of travel or no more than 3% slope at right angles to the direction of travel.

5.7 **Test Speed**—A means to measure the test speed within an accuracy of  $\pm 2\%$  of actual speed.

5.8 **Test Weight**—A means for weighing wheel loads within an accuracy of  $\pm 2.5\%$ .

5.9 **Time to Stop**—A means to measure the stopping time within an accuracy of  $\pm 1\%$ .

5.10 **Tire Pressure**—A means to measure tire inflation pressure within an accuracy of  $\pm 3\%$ .

5.11 **Towing Force**—An instrument to measure towing force (tension and compression) within an accuracy of  $\pm 3\%$ , and with a towing force indicator visible to the test machine operator.

5.12 **Towing Machine**—Towing machine with sufficient power and weight to pull the test machine as required. The device connecting the towing machine to the test machine shall be substantially horizontal.

5.13 **Wind Velocity**—A means to measure wind velocity within an accuracy of  $\pm 2$  mph (3.2 km/h).

### 6. Test Procedure for Agricultural Equipment, Classes A, B, and C

#### 6.1 General

6.1.1 Examine the test machine to assure compliance with the test machine manufacturer's specifications of brake system components, lubrication type, reservoir levels, and tires. Set all tire pressure to the maximum of test machine manufacturer's specifications for the weight to be tested. All tests shall be conducted with the brake system fully operational per manufacturer's specifications and instructions. All power-assist adjustments (pressure, etc.) shall be set to the minimum of manufacturer's specification range.

6.1.2 Burnish or "break in" the test machine brakes as specified by manufacturer or as required to establish consistent braking performance.

6.1.3 Record test machine weight, individual wheel load distribution, and vertical tongue load where applicable.

6.1.4 Record ambient temperature, wind velocity and direction with respect to the test course. The test shall not be conducted when the wind velocity exceeds 20 mph (32.2 km/h) or when the ambient temperature is below  $40^\circ\text{F}$  ( $4^\circ\text{C}$ ) or above  $90^\circ\text{F}$  ( $32^\circ\text{C}$ ), unless it can be shown that the test results will not be significantly influenced.

6.1.5 The term "cold" brakes shall mean that the temperature does not exceed  $212^\circ\text{F}$  ( $100^\circ\text{C}$ ) at the radial midpoint of the open edge of each brake drum or at the periphery of each brake disc. Previous to each stop, maintain drum or disc temperature of  $212^\circ\text{F}$  ( $100^\circ\text{C}$ ) or less.

6.1.5.1 If the drum or the disc temperature cannot be conveniently measured, the machine manufacturer should specify an alternate point of measurement and specify a correction factor for that point.

6.1.5.2 Where it is impractical to measure the temperature of the brakes, these can be considered "cold" brakes when they have not been subjected to severe braking tests during the preceding hour, and that at least 5 min must elapse between each stop.

6.1.6 Auxiliary retarder, variable ratio drive, or other auxiliary braking devices shall not be used in the brake tests unless they are simultaneously actuated by the brake control, or unless such retardation is automatic

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with normal braking procedure. Description and use of such devices shall be noted in the test report.

6.1.7 Record a description of any unusual or erratic brake performance, noise characteristics, or parts failure observed during the tests.

6.1.8 All test stops conducted must be accomplished under control without pull or swerve which would take the test machine out of a test lane 4 ft (1.2 m) wider than the maximum width of the test machine.

### 6.2 Effectiveness Test Procedure

6.2.1 The test machine brakes are to be "cold" prior to each stop.

6.2.2 Two Effectiveness Tests shall be carried out: (1) with the test machine ballasted to the maximum machine weight as specified in paragraph 3.8, and (2) with the test machine unballasted.

6.2.3 Effectiveness Tests are to be conducted on the specified test course from an initial test machine velocity of 15 mph (24.1 km/h) or maximum test machine speed recommended by manufacturer, whichever is less, to define clearly minimum stopping distance and brake input force (paragraph 6.1.8). The foot-control input force shall not exceed 200 lb (890 N). The hand-controlled input force shall not exceed 88 lb (391 N).

6.2.4 Stopping distance, as specified in paragraph 3.13, (and maximum deceleration rate—optional) is to be measured from a stabilized travel speed with the engine not contributing to the braking effort, except as noted in paragraph 6.1.6.

### 6.3 Fade and Recovery Test Procedure

6.3.1 Starting from a "cold" condition, with the test machine ballasted at the maximum machine weight, the service brakes are to be heated by towing at a speed of 12.4 mph (20 km/h) or at 80% of maximum machine speed, whichever is less, with engine clutch disengaged or transmission in neutral and with input to the service brake system sufficient to maintain a constant drawbar pull equal to 10% maximum machine test weight over a distance of 0.62 mile (1 km). Record required brake control force inputs at the beginning and end of this heating cycle.

6.3.2 Immediately disconnect the towing machine and repeat the Effectiveness Test at the maximum machine weight, using the brake input force limits specified in paragraph 6.2.3, to demonstrate the minimum controlled stopping distance (paragraph 6.1.8). This test to be completed within 3 min of the completion of the heating cycle (paragraph 6.3.1).

6.3.3 After cooling the brakes to a "cold" condition, repeat the Effectiveness Test at the maximum machine weight to determine recovery characteristics.

### 6.4 Wetted Brake Effectiveness and Recovery Test Procedure

6.4.1 Perform the Effectiveness Test at the maximum machine weight, after flooding the test machine's brakes with water for a minimum of 2 min. This test is not applicable to fully sealed brake systems.

#### 6.4.2 RECOVERY TEST

6.4.2.1 After flooding the brake facings for a minimum of 2 min, conduct the Recovery Test by towing the machine at 80% of maximum machine speed or 12.4 mph (20 km/h), whichever is less, and with the engine not contributing to the braking effort. Brake applications at 2 min intervals are to be run, measuring the input pedal force (within limits specified in paragraph 6.2.3) required to produce a drawbar force of 25% of the maximum ballasted weight of test machine.

6.4.2.2 After drying the brakes, conduct the Effectiveness Test at the maximum machine weight to determine brake recovery characteristics (paragraph 6.2).

6.5 Secondary Brake System Test Procedure—Use the Effectiveness Test at the maximum ballasted machine weight to measure the performance of secondary braking systems (paragraph 6.2).

### 6.6 Parking Brake System Test Procedure

6.6.1 Parking brake holding tests are to be conducted on a level test course with the transmission of the maximum ballasted test machine in neutral. Pull the test machine from rest until a towing force equal to at least 20% of test machine maximum weight is developed. If parking brake input force is applied with hand control, maximum input is to be limited to 120 lb (534 N); if foot controlled, the maximum input is to be 200 lb (890 N).

6.6.2 Repeat paragraph 6.6.1 in reverse direction.

6.6.3 Parking brake tests may be optionally conducted on a 20% slope.

6.6.4 If test machine is equipped with a positive transmission locking device (park position) rather than a parking brake, apply a drawbar pull equal to at least 20% of the test machine maximum weight in each direction. Test may be optionally conducted on a 20% slope as described in paragraph 6.6.3.

## 7. Test Procedure for Trailed Agricultural Equipment with Brakes

### 7.1 General

7.1.1 Connect the test machine to a towing machine in a manner representing normal usage and manufacturer's recommendation for the test machine. The test machine brake actuating system must be separate from the towing machine brake actuating system, unless the test machine is to be limited by manufacturer's recommendation to a specified towing machine or actuating system. A towing force indicator shall be inserted between the test machine and towing machine in such a manner that only towing forces are indicated and no vertical weight transference is shown.

7.1.2 Perform all steps in paragraph 6.1.

### 7.2 Effectiveness Test Procedure

7.2.1 The test machine brakes are to be "cold" prior to each stop.

7.2.2 The Effectiveness Test shall be carried out with test machine ballasted to the maximum machine weight specified by the manufacturer.

7.2.3 Effectiveness Tests are to be conducted from an initial velocity of 15 mph (24.1 km/h) or at a maximum trailing speed recommended by the manufacturer, whichever is less.

7.2.4 The test machine brake input force is to be operated at suitable increasing increments in individual tests until the minimum controlled trailed machine stopping distance (paragraph 6.1.8) as determined in paragraph 7.2.5 has been achieved, or until maximum test machine brake control force is reached. The maximum foot-control input force shall not exceed 200 lb (890 N). The maximum hand-controlled input force shall not exceed 88 lb (391 N). The towing machine brakes shall be applied with sufficient force to cause the towing force to be as constant and as near zero as possible (tension or compression) between test machine and towing machine.

NOTE: Towing force will be a positive compressive force for overrun type brakes.

7.2.5 Stopping distance, as specified in paragraph 3.13, is to be measured from a stabilized machine speed with the towing machine engine disengaged from the drivetrain.

7.3 Fade and Recovery Test Procedure—Perform Fade and Recovery Test per paragraph 6.3.

7.4 Wetted Brake Effectiveness and Recovery Test Procedure—Perform Wetted Brake Effectiveness and Recovery Tests per paragraph 6.4.

7.5 Uncoupling Brake Actuation Test Procedure—Conduct the maximum ballasted Effectiveness Test with the trailed test machine brakes automatically actuated by becoming uncoupled from the towing machine in a manner representing unintentional or accidental uncoupling at the towing machine drawbar.

7.6 Parking Brake Test Procedure—Perform parking brake tests per paragraph 6.6.

### 8. Minimum Performance Criteria

8.1 Service Brake Stopping Distance—Table 1 shows the stopping distances from an initial speed of 15 mph (24.1 km/h) or from maximum speed recommended by the manufacturer, whichever is less.

Test machines with primary speed retardation systems, other than conventional service brakes, must meet the same stopping distance specifications as given in paragraph 8.1.

### 8.2 Parking System Requirements

8.2.1 The parking system shall hold the test machine stationary in both forward and reverse direction on a 20% slope or equivalent loading, under all conditions up to the manufacturer's maximum machine weight rating.

8.2.2 The parking system when applied shall remain in the applied position in compliance with the above, despite any contraction of the brake parts, exhaustion of the source of energy, or leakage of any kind.

8.3 Secondary Braking System Requirements—Trailed equipment brakes, as applied by accidental or unintentional uncoupling as in paragraph 7.5, must be independent of the towing machine and capable of holding the test trailed machine weighted to manufacturer's maximum machine weight rating, on or against the equivalent pull of a 20% slope (forward or reverse) for a period of at least 15 min after actuation, and can be released only by a specific action of the operator.