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Braking System Test Procedures and Braking Performance Criteria for Agricultural Field Equipment



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1 Purpose

1.1 The purpose of this Standard is to establish requirements, minimum performance criteria, and performance test procedures for braking systems on agricultural field equipment.

Note: If a section of this standard provides details on a specific type of braking system, other braking systems can be used as long as they comply with the performance requirements of this standard.

2 Scope

2.1 The requirements, test procedures and performance criteria are directed to operation and parking of agricultural field equipment equipped with braking system(s) and having a maximum design speed exceeding 6 km/h (3.7 mile/h). Combinations of agricultural towing machines equipped with braking systems and towed agricultural machines without braking systems are included in this Standard.

3 Normative references

The following standard contains provisions which, through reference in this text, constitute provisions of this Engineering Practice. At the time of publication, the edition was valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Standards organizations maintain registers of currently valid standards.

ANSI/ASAE S390.4 JAN2005, Definitions and Classifications of Agricultural Field Equipment

ANSI/ASAE S279.14 JUL2008, Lighting and Marking of Agricultural Equipment on Highways

ISO 3583:1984, Road vehicles — Pressure test connection for compressed-air pneumatic braking equipment

ISO 5676: 1983, Tractors and machinery for agriculture and forestry — Hydraulic coupling — Braking circuit

4 Definitions

4.1 agricultural field equipment: Agricultural tractors, self-propelled machines, implements and combinations thereof designed primarily for agricultural field operations (per ASAE S390).

4.2 agricultural trailer: A transport machine used in agriculture which, according to its design, is suitable and intended for coupling to an agricultural tractor or self-propelled machine.

4.3 agricultural tractor: A traction machine designed and advertised primarily to supply power to agricultural implements and farmstead equipment (per ASAE S390).

4.3.1 two-wheel drive tractor: An agricultural tractor with traction power provided only through the rear tires (per ASAE S390).

4.3.2 two-wheel drive tractor with front assist: An agricultural tractor with primary power provided through the rear tires and assist power through the front tires (per ASAE S390).

4.3.3 four-wheel drive tractor: An agricultural tractor with full time power to all wheels (per ASAE S390).

4.3.4 two-wheel brake tractor: An agricultural tractor with braking provided only through the rear tires during service braking. This includes two-wheel drive tractors without front assist and/or front brakes, and two-wheel drive tractors with front assist that can not be automatically engaged during braking.

4.3.5 four-wheel brake tractor: An agricultural tractor with braking provided through all four tires during service braking. This includes four-wheel drive tractors with braking on one or two axles, and two-wheel drive tractors with front assist that is automatically engaged during service braking.

4.4 average deceleration: The retardation rate of a machine defined by the formula:

$$a = V^2 / 25.92 S$$

where:

a = average deceleration, m/s²

V = initial speed, km/h

S = stopping distance, m

4.5 braking control input force: The sum of all forces applied by the operator to the braking system control(s), as measured at the point of force application, in a line from the point of application through the operator's hip joint for foot pedal controls, or through the arm to shoulder joint for hand-operated controls.

4.6 cold brakes: A brake is deemed to be cold if one of the following conditions is met:

4.6.1 The temperature measured at the periphery of the disc or on the outside of the drum is below 100°C (212°F).

4.6.2 In the case of totally enclosed brakes including oil-immersed brakes, the temperature measured on the outside of the housing is below 50°C (122°F) or within the manufacturer's specifications.

4.6.3 The brake has not been actuated in the previous 1 h.

4.7 combination: Trailed equipment with or without braking systems coupled to an agricultural tractor or self-propelled machine.

4.8 maximum gross mass: The maximum permissible mass (weight) of the test machine in accordance with manufacturer's recommendations regardless of travel speed restrictions, and including maximum ballast, equipment and material load recommended or permitted.

4.9 maximum gross mass for stopping tests: The maximum permissible mass (weight) of the test machine in accordance with the manufacturer's recommendations for maximum transport speed or 50 km/h (31 mile/h) whichever speed is less.

4.10 parking brake system: A means for holding a machine continuously in a parked position.

4.11 secondary braking system: A braking system used for stopping a machine in the event of a malfunction in the operation or control of the service braking system.

4.12 self-propelled agricultural machine: An implement designed with integral power unit to provide both mobility and power for performing agricultural operations (per ASAE S390).

4.13 service braking system: The primary system(s) used for retarding and stopping a machine.

4.14 single-unit machine: A self-propelled machine not coupled to trailed equipment.

4.15 special self-propelled agricultural machine: An implement designed with integral power unit with front drive axle and major mass on front axle. (Examples: combine, cotton picker, windrower, etc.)

4.16 stopping distance: The distance traveled between the point at which the braking control is first moved and the point at which the machine comes to a stop.

4.17 stopping time: The time elapsed between the first movement of the braking control and the instant at which the machine comes to a stop.

4.18 test machine: The term used in this Standard to identify the agricultural machinery on which braking performance is measured by test.

4.19 towed agricultural machine: An implement that is designed to perform agricultural operations and is pulled by an agricultural tractor or self-propelled agricultural machine.

4.20 towing or towed force: The force required to move a machine in a specified manner by another machine which has the motive power.

4.21 unladen machine: A machine completely serviced with fuel, coolant, and lubricants, carrying a driver (if required) having a minimum weight of 75 kg (165 lb) but no optional accessories, weights, ballast or material load.

4.22 bulk carrier equipment: (see ASAE S390)

4.23 equipment mass ratio: The ratio of the maximum gross mass for stopping test divided by the mass of the unladen machine.

5 Classifications

5.1 For the purpose of this Standard, agricultural field equipment is classified in the following categories:

Category Ia — Two-Wheel Braked Agricultural Tractors

Ib — Four-Wheel Braked Agricultural Tractors

Category IIa — Self-Propelled Agricultural Machines

Iib — Special Self-Propelled Agricultural Machines

Category III — Agricultural Trailers

Category IV — Towed Agricultural Machines

6 Facilities and instrumentation

6.1 The following facilities and instrumentation capabilities are required:

6.1.1 **Ambient temperature.** A means of measuring ambient temperature within $\pm 3^{\circ}\text{C}$ ($\pm 5^{\circ}\text{F}$).

6.1.2 **Braking system input force.** An instrument to measure the applied force to the braking control, with an accuracy of $\pm 5\%$.

6.1.3 **Stopping distance.** A means of measuring the stopping distance with an accuracy of $\pm 1\%$.

6.1.4 **Test course.** The test course shall be straight and consist of a clean swept, level dry concrete or other hard clean surface with equivalent friction characteristics and of adequate length to conduct the test. The approach shall be of sufficient length, smoothness and uniformity of grade to assure stabilized travel speed of the machine. The braking surface shall not have more than 1% grade in the direction of travel or more than 3% grade at right angles to the direction of travel.

6.1.5 **Test speed.** A means of measuring the test speed with an accuracy of $\pm 2\%$.

6.1.6 **Test mass (weight).** A means for determining wheel loads with an accuracy of $\pm 3\%$.

6.1.7 **Tire pressure.** A means of measuring tire inflation pressure with an accuracy of $\pm 5\%$.

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

6.1.9 **Towing machine.** A towing machine with sufficient power and mass (weight) to pull the test machine. The device connecting the towing machine to the test machine shall be horizontal within ± 4 degrees when the machine is on a level surface.

6.1.10 **Wind velocity.** A means of measuring wind velocity with an accuracy of ± 3 km/h (± 2 mile/h).

6.2 Instrumentation to measure the following is optional:

6.2.1 **Brake temperature.** A temperature measuring system shall have $\pm 2\%$ accuracy.

6.2.2 **Braking system fluid pressure** (for Category III and IV only). A means of measuring braking system fluid pressure with an accuracy of $\pm 5\%$.

6.2.3 **Deceleration.** An instrument to measure and record average deceleration with an accuracy of $\pm 3\%$.

6.2.4 **Time to stop.** A means of measuring the stopping time with an accuracy of $\pm 1\%$.

6.3 **Braking system test report.** A typical braking system test report form is shown in Figure 1.

Manufacturer's Name and Address			
Vehicle Specification			
Make		Model	
Type		Serial No.	
Unladen Mass		Maximum Gross Mass kg	
Maximum Design Speed		Maximum Gross Mass (Stopping Tests) kg	
Location and Description of Axle or Tractive Device	Tire Size	Maximum Mass Technically Permissible on Each Axle or Wheel	Mass on Each Axle or Wheel as Tested
		kg	kg
		kg	kg
		kg	kg
		kg	kg
Service Braking Device(s) Specification		Brief Description of Parking Brake	
Make			
Type			
Secondary Braking Device(s) Specification			

Service Braking System	Test Results						
	Test Speed (km/h)	Brake Control Input Force (N)	Required Stopping Distance (m)	Measured or Calculated Stopping Distance (m)	Slope Percent (%)	Towing Force (N)	Brake Control Link Fluid Pressure Cat. III or IV
Stopping Performance Tests							
Maximum Gross Mass							
Unladen							
Fade Test							
Recovery Test							
Wetted Brake Test							
Recovery Test							
Holding Test							
(Forward)							
(Reverse)							
Parking Brake Holding							
(Forward)							
(Reverse)							
Secondary Braking System							
(Forward)							
(Reverse)							
Ambient Temperature				Test Surface			
Wind Speed/Direction				Date of Test			
Location of Tests				Wind Direction Relative to Test Course			

Figure 1 – Braking system test report

7 Test procedure for agricultural machines and combinations — Categories I and II

7.1 General

7.1.1 Examine the test machine to assure conformance with the manufacturer's specifications and operational instructions. This examination includes all control systems, braking systems' components, lubricant type(s), reservoir levels, tires, and distribution of load. Tires on braked wheels are to be the largest diameter that will achieve the desired loading conditions. Set all tire pressures to the maximum of manufacturer's specifications for the test mass (weight).

7.1.2 Specify and describe all braking and retarding devices included in the service braking system, secondary braking system, and/or parking brake system, as applicable for the machine being tested. These descriptions should correspond with the manufacturer's designations of braking systems.

7.1.3 Auxiliary retarder, variable ratio drive, engine exhaust brake, or other auxiliary braking devices may be used in the braking performance tests if one of the following conditions is met. Description and use of such devices shall be noted in the test report.

7.1.3.1 The device is simultaneously actuated by the braking control.

7.1.3.2 Retardation is automatic with normal braking procedure.

7.1.3.3 The manufacturer designates such device as a braking system (see clause 7.1.2).

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

7.1.5 Record test machine gross mass (weight), (as defined in clauses 4.8, 4.9 or 4.21), individual axle or wheel load distribution, and vertical hitch point load where applicable.

7.1.6 Record ambient temperature, wind velocity and wind direction with respect to the test course. The test shall not be conducted when the wind velocity exceeds 32 km/h (20 mile/h) or when the ambient temperature is below -10°C (14°F) or above 35°C (95°F) unless it can be shown that the test results will not be significantly influenced.

7.1.7 Record a description of any unusual or erratic brake performance or noise characteristics.

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

7.1.9 Safe operating procedures and practices should be observed during tests to control machines within their stability and control limitations.

7.2 Braking performance test procedure

7.2.1 The test machine brakes shall be cold, as defined by paragraph 4.6, prior to each stop. If the drum or the disc temperature cannot be conveniently measured, the machine manufacturer may specify an alternate point of measurement and a correction factor for that point.

7.2.2 Ballasted braking performance test shall be performed with the test machine at the maximum gross mass (weight) for stopping tests as defined in clause 4.9.

7.2.3 Unladen braking performance test shall be performed with the test machine as defined in clause 4.21.

7.2.4 Braking performance tests shall be conducted on the specified test course from an initial test machine speed of 50 km/h (31 mile/h) $+5\%$ -0% or maximum speed for the test machine recommended by the manufacturer, whichever is less, to measure minimum (shortest) stopping distance and corresponding braking control input force, without locking of the wheels.