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SURFACE VEHICLE STANDARD

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(R) MACHINERY FOR FORESTRY—WHEELED SPECIAL MACHINES—VOCABULARY, PERFORMANCE TEST METHODS, AND CRITERIA FOR BRAKE SYSTEMS

Foreword—This SAE Standard is identical to ISO 11169:1993, except for:

a. The addition of Section 2 titled "References" and renumbering succeeding sections and references
b. Insertion of SAE references in Sections 1 and 2
c. Revision of the Foot pedal (foot control) force in Table 2 from 600 N to 700 N

1. Scope—This SAE Standard lays down the vocabulary and specifies performance test methods and criteria to enable uniform assessment of the service, secondary, and parking brake systems of wheeled specially designed forestry machines.

This document applies to self-propelled, rubber-tired special forestry machines defined in SAE J1209 or ISO 6814 as skidders, fellers, forwarders, and the various combinations of these machines.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1209—Identification Terminology of Mobile Forestry Machines

2.1.2 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 6814-1983—Machinery for forestry—Mobile and self-propelled machinery—Identification vocabulary

3. Definitions—For the purposes of this document, the following definitions apply.

3.1 Brake Systems—All the components which combine together to stop and/or hold the machine. Such systems include the control(s), means of power transmission, the brake(s), and all parts connecting the brake to the wheel and tire.

3.1.1 SERVICE BRAKE SYSTEM—Primary system used for stopping and holding the machine.

3.1.2 SECONDARY BRAKE SYSTEM—System used for stopping the machine in the event of any single failure in the service brake system.

3.1.3 PARKING BRAKE SYSTEM—System used to hold a stopped machine in a stationary position.

3.1.4 BRAKE SYSTEM COMPONENTS—(See 3.1.4.1, 3.1.4.2, 3.1.4.3, 3.1.4.4.)

3.1.4.1 Control(s)—Component(s) directly activated by the operator to cause a force to be transmitted to the brake(s).

3.1.4.2 Brake Actuation System—All of the components between the control(s) and the brake(s) which connect them functionally.

3.1.4.3 Brake(s)—Components which directly apply a force to oppose movement of the machine. Brakes may, for example, be of friction, electrical, or fluid types.

3.1.4.4 Retarder—Energy-absorption device normally used to control machine speed while descending gradients.

3.2 Common Component—Component that performs a function in two or more brake systems.

3.3 Machine Mass—Mass of the machine which includes the heaviest combination of manufacturer approved equipment (i.e., winch, dozer, felling head, grapple, etc.) and components (i.e., cab, protective structures, etc.), an operator of 75 kg, and full fuel, lubricating, hydraulic, and cooling systems. The mass of forwarders includes the manufacturer's rated payload.

3.4 Stopping Distance, s—Distance traveled by the machine from the point on the test course at which the machine brake control is initially actuated to the point where the machine comes to a complete halt.

3.5 Mean Deceleration, a—Average rate of change of the velocity of the machine from the instant the brake control is initially actuated until the machine comes to a complete halt.

The mean deceleration, a, in meters per second squared, may be determined from Equation 1:

$$a = \frac{v^2}{2s} \qquad \text{(Eq.1)}$$

3.6 Burnish—Procedure to condition the frictional surfaces of the machine brake(s).

3.7 Brake Reservoir Pressure—Pressure in the air or hydraulic reservoir(s), if so equipped, to assist the application of force to the brakes.

3.8 Brake System Pressure—Gas or hydraulic pressure available at the brake mechanism.

3.9 Test Course—Surface upon which the test is carried out.

3.10 Cold Brakes—Brakes in one of the following conditions:

a. The brakes have not been actuated in the previous 1 h, except in accordance with 6.9;
b. The brakes have been cooled to 100 °C or less when measured on the brake disc or the outside of the brake drum;
c. In the case of totally enclosed brakes, including oil-immersed brakes, the temperature measured on the outside of the housing is below 50 °C, or within the manufacturer's specification.

4. ***Instrument Accuracy***—The instruments used to carry out the required measurements shall be accurate to the levels given Table 1:

TABLE 1—INSTRUMENT ACCURACY LEVELS

Parameter being measured and related unit	Instrument accuracy
Brake system pressure (kPa)	±3
Machine speed (km/h)	±3
Machine mass (kg)	±2.5
Stopping distance (m)	±1
Brake control actuating force (N)	±3
Slope (%)	±1

5. ***General Requirements***—The requirements for brake systems in 5.1 to 5.6 apply to all machines indicated in Section 1.

5.1 Required Brake Systems—All machines shall be equipped with:

a. A service brake system
b. A secondary brake system
c. A parking brake system

No brake system shall be connected to the wheel and tire through a disconnect such as a clutch or shiftable gearbox.

5.2 Common Components—Brake systems may use common components; however in the event of a failure of any single component other than a tire, the brake systems shall be capable of bringing the machine to a halt in accordance with performance requirements specified for the secondary brake system in 7.6.3.4.

5.3 Service Brake System

5.3.1 All machines shall meet the service brake performance requirements of 7.5 and 7.6.

5.3.2 The temperature of brake components exposed to debris shall not exceed 120 °C over ambient when measured within 1 min after completing the stopping test described in 7.6. The point of measurement shall be the outer surface of the drum or the periphery of the disc.

5.3.3 If other systems are provided with power from the service brake system, any failure in these systems shall be considered as a failure in the service brake system.

5.4 Secondary Brake System—All machines shall meet the secondary brake performance requirements of 7.6.

The secondary brake system shall be actuated by a manual control. In addition, automatic application is permitted if a warning device is actuated prior to the automatic application.

5.5 Parking Brake System

5.5.1 All machines shall meet the parking brake performance requirements of 7.5.

5.5.2 All machines shall be equipped with a parking brake system capable of being applied by a person seated in the driver's seat.

5.5.3 While applied, the parking brake system shall maintain parking performance in compliance with 7.5 despite any contraction of the brake parts, exhaustion of the source of energy, or leakage of any kind.

5.5.4 The parking brake system may use common components which also form part of other brake systems provided that the requirements given in 7.5 are met.

5.6 Warning Device

5.6.1 The service brake system using stored energy as its primary application force shall be equipped with a warning device which actuates before system energy drops below either 50% of the manufacturer's specified maximum operating energy level or the level required to meet the secondary brake performance requirements, whichever is higher.

This warning device shall be readily visible and/or audible to the operator, and provide a continuous warning. Gauges shall not be acceptable to meet these requirements.

5.6.2 Any friction-type parking brake system not automatically disengaged by engagement of the transmission, or which does not automatically disengage the transmission when applied, shall be equipped with a warning device which is activated when the engine is running, the transmission is engaged, and the parking brake is engaged.

This warning device shall provide continuous warning to the operator. Gauges shall not be acceptable to meet these requirements.

6. Test Conditions

6.1 Precautions specified by the manufacturer shall be taken while carrying out performance tests.

6.2 The test course shall consist of a hard, dry surface with a well-compacted base. Ground moisture may be present to the extent that it does not adversely affect the braking test.

The test course shall not have a gradient of more than 3% at right angles to the direction of travel. Gradient in the travel direction shall be as specified for the test being carried out.

The approach to the test course shall be of sufficient length, smoothness, and uniformity of gradient to ensure the required machine speed is reached before the brakes are applied.

6.3 The machine mass shall be as defined in 3.3 and shall not exceed the axle distribution specified by the manufacturer. The manufacturer's rated payload shall be included for forwarders only, up to the maximum machine gross mass and the axle loads approved by the manufacturer.

6.4 All parameters relating to brake systems, i.e., tire size and pressure, brake adjustment, warning device actuation point, etc., shall be within the machine manufacturer's specifications. All the brake system pressures shall be within the machine manufacturer's specification range. No manual adjustment shall be made to the brake system during any single performance test.

6.5 When the machine transmission provides a selection of gear ratios, the stopping tests shall be carried out with the transmission in a gear suitable for the test speed specified. The powertrain may be disengaged prior to completing the stop.

6.6 Retarders shall not be used in these tests unless the retarder is simultaneously actuated by the applicable brake system control.

6.7 Blades, grapples, and other equipment shall be carried in the transport position recommended by the manufacturer.

6.8 Burnishing or conditioning of brakes before testing is permissible. The burnishing procedure shall be indicated in the operator's and/or maintenance manual for the machine and shall be verified by consulting the machine manufacturer.

6.9 Immediately prior to a test, the machine shall be operated until the machine fluids, i.e., engine and transmission oils, are at normal operating temperature.

6.10 Machine speed shall be measured immediately prior to the brake control being applied.

6.11 As a minimum requirement, all data required for the completion of the test report in Section 8 shall be recorded and reported.

7. Performance Tests

7.1 Brake System Control

7.1.1 Control forces needed to meet the required braking performance for the systems defined in 3.1 shall not exceed the levels given in Table 2.

TABLE 2—MAXIMUM TEST FORCE LEVELS FOR BRAKING SYSTEM CONTROLS

Type of control	Maximum test force to be applied N
Finger grasp	20
Hand grasp	
- upwards	400
- fore/aft	300
- sideways	300
Foot pedal (foot control)	700
Foot pedal (ankle control)	350

7.1.2 All brake system controls shall be capable of being applied by someone sitting in the operator's seat. The secondary and parking brake system(s) control(s) shall be arranged so that they cannot be released from the operator's seat once they have been applied unless they can be reapplied immediately from the operator's seat.

7.2 Service Brake System Recovery Capacity (Stored Energy System)—The engine speed control (throttle) shall be set to obtain maximum engine rotational speed (r/min) or frequency (min-1). The service brake system shall be capable of delivering at least 70% of the pressure measured during the first brake application after the service brake has been fully applied 20 times at the rate of six applications per minute.

Calculate the percentage of the service brake system stored energy residual pressure, δp, after the brake application test, from Equation 2:

$$\delta p = \frac{\rho 2}{\rho 1} x100 \qquad \text{(Eq.2)}$$

where:

ρ1 = the brake pressure during the first brake application
ρ2 = the lowest brake pressure measured during subsequent brake applications

7.3 Secondary Brake System Capacity (Stored Energy System)—If the stored energy reservoir(s) of the service brake system are used to apply the secondary brake system, then with the energy source disconnected and the machine stationary, the capacity of the service brake system reservoir(s) shall be such that energy remaining in the reservoir(s) after five full service brake applications shall not be less than that required to meet the secondary stopping requirements specified in 7.6.3.4.

7.4 Warning Device for Stored Energy System—The service brake system energy shall be reduced by any suitable means. The warning device (see 5.6.1) shall be activated before the system energy drops below either 50% of the maximum stored energy level specified by the manufacturer or the stored energy level required to meet the secondary stopping requirement specified in 7.6.3.4, whichever level is higher. The warning device shall be activated before a secondary brake system is automatically applied.

7.5 Holding Performance

7.5.1 The service brake system shall have a capability equivalent to holding the machine stationary, in both forward and reverse directions, on a 40% gradient with the machine mass specified in 6.3.

7.5.2 The parking brake shall have a capability equivalent to holding the machine stationary, in both forward and reverse directions, under the conditions specified in 7.5.1.

7.5.3 If the machine slides or if it is otherwise impractical to test on a 40% gradient, use the surface specified in 6.2 with not more than 1% gradient in the travel direction. Apply a horizontal pulling force as near the ground as practical to the stationary test machine with the brake system applied and the transmission in neutral. The test machine holding brake force, in Newtons, shall be not less than 3.64 times the machine mass in kilograms.

7.6 Stopping Performance

7.6.1 REQUIREMENTS—The service and secondary brake systems shall stop the machine within the following respective stopping distances, s, in meters, when tested in accordance with 7.62 to 7.64:

a. For the service brake system (Equation 3):

$$s = \frac{v^2}{80} \qquad \text{(Eq.3)}$$

b. For the secondary brake system (Equation 4):

$$s = \frac{v^2}{53} \qquad \text{(Eq.4)}$$

where:

v in a and b is the machine speed, expressed in kilometers per hour.

For both a and b, machines with a maximum level surface speed lower than 32 km/h shall add the following correction to the stopping distance equation:

$$+ 0.1 \times (32 - v)$$

For b alone, see 7.6.3.4 for the altemative secondary brake exception.

7.6.2 TEST CONDITIONS

7.6.2.1 Brake performance shall be tested from a machine speed of 32 km/h ± 3 km/h or the maximum level surface speed of the machine, if less.

7.6.2.2 Tests shall be carried out in accordance with the test conditions specified in Section 6.

7.6.2.3 The test course shall not have more than 1% gradient in the travel direction.

7.6.3 COLD TESTS

7.6.3.1 Starting out with cold brakes, stopping distance tests for service brake and secondary brake systems shall be carried out twice in the forward direction of machine travel, once in each direction of the test course, with at least 10 min between stops.

7.6.3.2 Stopping distance and machine speed used when reporting the test results (see Section 8) shall be the average of the two tests (once in each direction of the test course) described in 7.6.3.1.

7.6.3.3 The service brake system shall stop the machine within the stopping distance specified in 7.6.1a.

7.6.3.4 The secondary brake system shall stop the machine within the distance specified in 7.6.1b.

If the machine is equipped with a retarder, it may be used prior to and during this test. When the retarder is used, the machine manufacturer shall include in the operator's manual the maximum machine speed and/or the transmission gear to be engaged when the machine is traveling down specified gradients. An instruction plate shall be placed in the operator's compartment and be readily visible to the operator.

If the service and secondary brake systems are actuated by only one control, an independent brake system shall be provided as an alternative secondary brake. The alternative secondary brake shall stop the machine within the stopping distance, s, in meters, calculated from Equation 5:

$$s = \frac{v^2}{40} \qquad \text{(Eq.5)}$$

where:

v = the velocity of the machine, in kilometers per hour, immediately prior to the brake control being applied.

7.6.4 PROCEDURE FOR HEAT FADE TEST

7.6.4.1 Machines shall be tested as stated in 7.6.2.

7.6.4.2 The service brakes shall be applied and released to complete four consecutive stops at or as near as possible to the maximum deceleration of the machine without causing the wheels to lock. The machine shall be returned to the initial test speed after each stop using maximum machine acceleration capability. A fifth consecutive stop shall be measured and shall not exceed 125% of the stopping distance specified in 7.6.1.

8. Test Report—The test report shall contain at least the following information:

a. A reference to this standard
b. The type of machine
c. The make of machine
d. The model and serial number of the machine
e. The condition of the brake system (for example, new, in operation for 10 h, etc.)
f. The mass, in kilograms, and the axle loads, in Newtons, of the machine as tested
g. The manufacturer's approved maximum machine mass, in kilograms, and the axle loads, in Newtons
h. The size, ply rating, tread pattern, and tire pressures in megapascals
i A description of the brakes (for example, disc or drum, hand or foot control)
j. The type of brake systems (for example, mechanical or hydraulic)
k. Which tests were carried out using a retarder and a description of the retarder (for example, hydraulic or electric)
l. The surface of the test course (for example, asphalt, concrete, or soil)
m. The longitudinal and cross gradients of the test course
n. The results of all stopping and holding tests, given in table form as shown in Table 3 (see 7.5 and 7.6)
o. Percentage of the service brake system stored energy after the brake application test, calculated as specified in 7.2
p. The force levels applied to the controls (see 7.1.1)
q. The maximum level surface speed in kilometers per hour
r. The secondary brake system capacity for a stored energy system (see 7.3)