SURFACE VEHICLE STANDARD

J1789	REAF. AUG2014
Issued 2002-08 Reaffirmed 2014-08 Superseding J1789 SEP2007	

Self-Propelled Sweepers and Scrubbers Braking Performance

RATIONALE

J1789 has been reaffirmed to comply with the SAE five-year review policy.

1. ***Scope***—This SAE Standard applies to self-propelled, rider operated, sweepers and scrubbers as defined in SAE J2130 with maximum machine level surface speeds up to 32 km/h. Machines capable of speeds equal to and greater than 32 km/h are not covered by this document.

1.1 Purpose

1.1.1 To provide minimum performance criteria for service braking systems, secondary stopping systems and parking brake systems for self-propelled street sweepers, industrial sweepers and industrial scrubbers.

1.1.2 To provide test criteria by which machine braking system performance may be verified.

1.2 Rationale—This document has been reaffirmed to comply with the SAE 5-Year Review policy.

2. ***References***

2.1 Applicable Publications—The following standards form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of the publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 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 J2130—Self-Propelled Sweepers

2.1.2 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 6014:1986—Earth-moving machinery—Determination of ground speed
ISO 6016:1982—Earth-moving machinery—Methods of measuring the masses of whole machines, their equipment and components
ISO 9248:1992—Earth-moving machinery—Units for dimensions, performance and capacities, and their measurement accuracies

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3. Definitions

3.1 Self-Propelled Sweepers and Scrubbers—Machines for sweeping and scrubbing floors and roads as defined in SAE J2130.

3.2 Brake Systems—All the components which combine together to stop and/or hold the machine. Such systems include the control(s), means of brake actuation and the brake(s).

3.3 Service Brake System—Primary system used for stopping and holding the machine.

3.4 Secondary Brake System—System used for stopping the machine in the event of any single failure in the service brake system.

3.5 Parking Brake System—System used to hold a stopped machine in a stationary position.

3.6 Brake System Components

3.6.1 BRAKE CONTROL(S)—Component(s) directly activated by the operator to cause a force to be transmitted to the brake(s).

3.6.2 BRAKE ACTUATION SYSTEM—All components between the control(s) and the brake(s) which connect them functionally.

3.6.3 BRAKE(S)—Components which directly apply a force to oppose movement of the machine. Brakes may, for example, be of friction, electrical, hydrostatic or other fluid types.

3.7 Common Components—Components that perform a function in two or more brake systems.

3.8 Machine Mass—Mass of the machine that includes the heaviest combination of manufacturer approved equipment and components (i.e., cab, protective structures, etc.), rated payload, an operator of 75 kg, full fuel, lubricating, hydraulic and cooling systems. The machine mass and payload distribution shall be according to the manufacturer's specification.

3.9 Stopping Distance, s—Distance travelled 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 stop.

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

3.11 Brake System Pressure—Fluid pressure available to the brake control.

3.12 Brake Application Pressure—Fluid pressure measured at the brake.

3.13 Modulated Braking—Capability to continuously and progressively increase and decrease the braking force by operation of the brake control.

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

3.15 Cold Brakes—Expression designating brakes where;

The brakes have not been actuated in the previous 1 hour,
or
The brakes have been cooled to 100 °C or less when measured on the brake disk or on the outside of the brake drum,
or

In the case of totally enclosed brakes, including oil-immersed brakes, the temperature measured on the outside of the housing closest to the brake is below 50 °C or within the manufacturer's specifications.

3.16 Maximum Machine Level Surface Speed (V)—Machine speed in kilometers per hour, determined in accordance with ISO 6014.

4. Instrument Accuracy—Test instruments used to carry out the required measurements shall conform to the requirements of ISO 9248.

5. General Requirements—The following requirements for brake systems apply to all machines described in Section 1.

5.1 Required Brake Systems

5.1.1 The machine shall have the following brake systems;

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

5.1.2 No brake system shall contain a disconnecting device such as a clutch or a shiftable gearbox that allows the brake(s) to be disabled.

5.1.3 A power source disconnect designed for cold weather starting which also disables a brake system shall require application of the parking brake prior to disconnection.

5.2 Common Components—Brake systems may use common components. However, a failure of any single component other than a tire, or a failure of any single common component shall not reduce the effectiveness of the machine's stopping capability to less than the secondary performance defined in 7.6.2.4, with one exception: a common control (lever, pedal, switch, etc.) may be used to actuate combined service and secondary brake systems provided that another dynamic braking capability is provided that will stop the machine within 120% of the dynamic stopping distances shown for the secondary brakes in 7.6.2.4. This braking capability may be applied automatically and without modulation.

5.3 Service Brake System

5.3.1 All machines shall meet the service brake performance requirements of 7.5 and 7.6.2.3.

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

5.3.3 All machines shall have brakes of equal nominal capacity rating applicable to each wheel of at least one axle.

5.3.4 The service brake system shall be of the modulated type as defined in 3.13.

5.4 Secondary Brake System

5.4.1 All machines shall meet the secondary brake performance requirements of 7.6.2.4.

5.5 Parking Brake System

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

5.5.2 After being applied, this system shall not depend on an exhaustible energy source. The parking brake system may use common components with other brake systems provided the requirements of 7.5 are met.

5.6 Warning Device for Stored Energy Sources—If stored energy is used for the service brake system, that system shall be equipped with a warning device which is activated before the system energy drops below 50% of the maximum operating energy level specified by the manufacturer or the level required to meet the secondary brake performance requirements, whichever level is higher.

The device shall readily attract the operator's attention by providing a continuous visible and/or audible warning. Gauges indicating pressure or vacuum do not meet this requirement.

6. Test Conditions

6.1 The manufacturer's safety precautions and correct operating procedures shall be observed while carrying out performance tests.

6.2 The test course surface shall be clean, dry, level asphalt, brushed concrete, or equivalent. The test course shall be of sufficient length to permit a stabilized travel speed of the machine before application of the brakes. The braking surface shall not be of a slope greater than 1% in the direction of travel, or more than 3% slope at right angles to the direction of travel.

6.3 The machine shall be loaded to the maximum machine mass as per 3.8.

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

6.5 When the machine's transmission provides a selection of gear ratios, the stopping tests shall be conducted with the transmission in the gear corresponding to the test speed specified. The power train may be disengaged prior to completing the stop.

6.6 Payload sweeping hoppers and debris containers shall be positioned in the transport (i.e., lowered) position during the tests.

6.7 Burnishing or conditioning of the 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 consultation with the machine manufacturer.

6.8 Immediately prior to the tests the machine shall be operated until the machine fluids, i.e., engine and transmission oils, are at normal operating temperature as specified by the manufacturer.

6.9 Machine test speed shall be that speed measured immediately prior to the brake control being applied.

7. Performance Requirements

7.1 Brake System Controls

7.1.1 The control forces to meet the required brake performance for the systems defined in 7.5, 7.6.2.3, and 7.6.2.4 shall not exceed the values given in Table 1.

TABLE 1—MAXIMUM FORCE LEVELS FOR BRAKE SYSTEM CONTROLS FOR PERFORMANCE TESTS

Type of Control	Maximum Force to be Applied
Foot pedal (leg control)	600 N
Foot treadle (ankle control)	350 N
Hand grasp (upwards)	400 N
Hand grasp (downwards, sideways, fore-aft)	300 N
Finger grasp (flip levers & switches)	20 N

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

7.2 Service Brake System Recovery Capacity (Stored Energy System)—The engine speed control shall be set to obtain maximum engine rotational speed (r/min) or frequency (min^{-1}). The brake application pressure shall be measured near a brake. The service brake system shall be capable of delivering at least 70% of the pressure measured during the first brake application after the service brakes have been fully applied 12 times at the rate of 6 applications per minute.

Calculate the percentage of the service brake system stored energy after the brake application test calculated from the following formula:

$$p = \frac{P_2}{P_1} \times 100 \qquad \text{(Eq. 1)}$$

where:

p is the residual pressure as a percentage,
p_1 is the brake application pressure during the first brake application,
p_2 is the lowest brake application pressure measured during subsequent brake applications;

7.3 Secondary Brake System Capacity (Stored Energy System)—Where stored energy reservoir(s) for the service brake is (are) used to supply the energy for the secondary brake, the capacity of the reservoir(s), with the energy source disconnected and the machine stationary, shall maintain sufficient energy after five full service brake applications to meet the secondary brake requirements specified in 7.6.2.4.

7.4 Warning Device for Stored Energy System—If the service brake system energy is reduced by any means, a warning device (see 5.6) shall activate before the system energy drops below the greater of 50% of the manufacturer's specified maximum operating energy level, or the stored energy level required to meet the secondary brake requirements specified in 7.6.2.4. The warning device shall activate prior to an automatic application of the secondary brake system.

7.5 Holding Performance—All machines shall be tested in both the forward and reverse directions in accordance with the machine conditions as specified in Section 6.

The service brake and park brake system shall be capable of holding the machine on a slope with the power train disengaged (unless a hydrostatic transmission is used for the service brake system) as given in Table 2: