

SAE-J1152

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drivetrain or as an alternate, the motors and gear final drives may be disengaged from the drive train before stopping distance tests are run.

4.2.1.1 *Alternate Test for Machines Using Hydrostatic Drives*—If it is difficult to remove the hydrostatic motor retarding force, or to disengage the motor and gear final drive from the drive train, the secondary braking system may be tested in the following way:

With the unit stationary, variable motors set to maximum displacement, and any mechanical transmissions set in the lowest speed range, apply the secondary brake and engage the hydrostatic drive system at full rated pressure alternately in forward and reverse. The unit must remain stationary. The brake must be capable of stopping a moving vehicle.

4.2.2 APPLICATION—The secondary system shall be capable of being applied from the operator's position. The system shall be arranged so that it cannot be released by the operator unless immediate reapplication can be made to stop the machine.

4.2.2.1 *Automatic Application, Stored Energy System Excluding Hydrostatic Systems*—The secondary braking system may be applied automatically in addition to the manual control. With automatic application, a continuous audible or visual warning device should activate before the secondary braking system applies.

4.2.2.2 *Automatic Application, Hydrostatic Systems*—The secondary braking system may be applied automatically, without any warning device activation, if the braking system releases hydraulically and is spring applied with loss of hydraulic system charge pressure.

4.3 **Parking Brake System**—All machines shall be equipped with a parking brake system capable of being applied and released from the operator's position.

4.3.1 **PARKING BRAKE SYSTEM PERFORMANCE ON GRADE OR SIMULATED GRADE**—The parking brake system shall have the capability of holding the machine stationary on a 15% grade with the machine at maximum gross machine mass including all accessories and capacities per the manufacturer's specifications. The test course shall be as specified in paragraph 5.1.1 except for grade. This criteria applies to both forward and reverse direction.

4.3.1.1 *Alternate Tests*—If the test specified in paragraph 4.3.1 is impractical, either of the following tests may be conducted:

1. Test unit on a tilt platform with a skid resistant surface tilted to a 15% angle.

2. Test unit by applying a pulling force to a stationary machine with the parking brake set and transmission in neutral or if hydrostatic drive, with pump bypassed. The test course will be described in paragraph 5.1.1. This force shall be applied horizontally to achieve a minimum force equivalent to a 15% grade. This force in N is machine mass in Kg times 1.46.

4.3.2 **REMAIN APPLIED**—The parking brake system when applied shall maintain the parking performance in compliance with paragraph 4.3.1 despite any contraction of the brake parts, exhaustion of energy, or leakage of any kind.

5. Brake Test Criteria

5.1 Facilities and Instrumentation

5.1.1 The test course shall consist of a hard, dry surface (ground moisture may be present to the extent that it does not adversely affect the braking surface) with a well compacted base. The approach will be of sufficient length, smoothness, and uniformity of grade to assure stabilized travel speed of machine. The test course shall not have more than 3% grade at right angles to the direction of travel. Grade in the direction of travel shall be as specified for the test being conducted.

5.1.2 A means to measure stopping distance with an accuracy of $\pm 1\%$.

5.1.3 A means to measure machine test speed with an accuracy of $\pm 3\%$.

5.1.4 A means for determining machine mass (weight) with an accuracy of $\pm 2.5\%$.

5.1.5 A means for measuring the braking system energy source, when applicable, with an accuracy of $\pm 3\%$.

5.1.6 A means for measuring the force required by the operator to actuate the braking system with an accuracy of $\pm 3\%$.

5.2 Test Requirements

5.2.1 All parameters related to braking systems shall be within the machine manufacturer's specifications; that is, tire size and pressure, brake adjustment, warning device actuation point, etc. All power-assist pressures shall be within the machine manufacturer's specification range. No manual adjustment(s) shall be made to the brake system during any one performance test.

5.2.2 **MACHINE MASS**—Machine to be tested with maximum fuel and sprinkler water, and at manufacturer's stated maximum mass.

5.2.3 Stopping distance is to be measured in meters from the point at which the brake control application begins to the point at which the machine is at rest.

5.2.4 Stopping tests are to be conducted from maximum machine speed.

5.2.5 Stopping tests shall be conducted with the transmission in the gear commensurate with the speed required in paragraph 5.2.4 where applicable. The power train may be disengaged prior to completing the stop.

5.2.6 Retarders shall not be used in these tests unless the specific test states otherwise or the retarder is always activated by the brake control that is used to activate the service or secondary braking system being tested.

5.2.7 Control force input necessary to apply the braking systems to achieve the required braking performance shall not exceed the following values:

Control Type	Force
Finger Grasp	20 N
Hand Grasp	
Upwards	400N
Fore-Aft	300N
Sideways	300N
Foot Pedal	700N
Foot Treadle	350N

5.2.8 On machines where hydrostatic braking is used as the service brake, the stopping and holding performance of this system shall be conducted with the engine running.

5.2.9 When testing a vibratory machine, all tests shall be conducted without vibration.

TABLE I—BRAKE PERFORMANCE REQUIREMENTS

Machine Operating Mass Kg M	Service Brake System Stopping Distance L for Mass M	Secondary Brake System Stopping Distance L for Mass M
< 5,400	$L = 0.14V + 0.02V^2$	$L = 0.134V + 0.058V^2$
> 5,400	$L = 0.2V + 0.02V^2$	$L = 0.22V + 0.057V^2$
< 13,600	$L = 0.28V + 0.02V^2$	$L = 0.29V + 0.057V^2$
> 13,600		

L = stopping distance meters (m)

V = machine speed in kilometers per hour (km/h)

M = machine operating mass in kilogram (kg)

ed. BRAKING PERFORMANCE—RUBBER-TIRED CONSTRUCTION MACHINES—SAE J1152 APR80

SAE Recommended Practice

Report of the Construction Machinery Technical Committee, approved July 1976, editorial change April 1980. This document incorporates material from SAE J166, J236, J237, J319, and J1080, which have been discontinued. Rationale statement available.

1. **Scope**—Minimum performance criteria for service braking systems, emergency stopping systems, and parking systems for off-highway, rubber-tired, self-propelled loaders, dumpers, tractor scrapers, graders, cranes, ex-

cavators, and tractors with dozer are provided in this SAE Recommended Practice. Refer to SAE J1057 (July, 1973) and J116 (July, 1975) (Sections 1.1, 1.2, and 2) for machine identification.



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2. Purpose

2.1 To define minimum braking system performance for in-service machines.

NOTE: This is not a design standard.

2.2 To provide test criteria by which machine braking system compliance may be verified.

3. Braking Systems

3.1 **Service Braking System**—The primary system of any type used for stopping and holding the machine.

3.2 **Emergency Stopping System**—The system used for stopping in the event of any single failure in the service braking system.

3.3 **Parking System**—A system to hold stopped machine stationary.

NOTE: Common Components—The above braking systems may use common components. However, a failure of a common component shall not reduce the effectiveness of the machines stopping capability below the emergency stopping performance as defined in paragraph 4.2.1.

4. Braking System Performance

4.1 **Service Braking System**—All tractor scrapers and dumpers shall have braked wheels on at least one axle of the prime mover and one axle of each trailing unit. All other machines shall have at least two braked wheels (one right hand and one left hand).

4.1.1 **STOPPING PERFORMANCE**—The service braking system, when tested in accordance with Section 5, shall stop the machine within the distance specified in the appropriate table.

4.1.2 **HOLDING PERFORMANCE**—The service braking system shall have capability equivalent to holding the machine stationary on a dry swept concrete grade under conditions as listed:

Machine	Grade	Condition
Loaders	30%	Loaded to manufacturers gross mass (weight) rating and distribution. Bucket to be in SAE carry position.
Dumpers & Tractor Scrapers	25%	Loaded to manufacturers gross machine mass (weight) rating and distribution.
Graders	30%	Cutting edge to be in the transport position.
Cranes & Excavators	25%	Unloaded, with components in the transport position as recommended by the manufacturer.
Tractors with ed. Dozer	30%	Lowest part of cutting edge to be 460 mm (18 in) above test surface.

The criteria shall apply to both forward and reverse directions.

4.1.3 **SYSTEM RECOVERY**—With the machine stationary, the service braking systems primary power source shall have capability of delivering at least 70% of maximum brake pressure measured at the brakes when the brakes are fully applied twelve (12) times at the rate of four (4) applications per minute with the engine at maximum governed rpm for dumpers, tractor scrapers, cranes

ed. TABLE 1—LOADERS, TRACTORS WITH DOZERS—Brake Performance Requirements (SI Units)

Machine Mass kg	Machine Speed, km/h									
	6	10	14	18	22	26	30	34	38	42
	Service Brake Maximum Stopping Distance—Metres (Emergency Brake Stopping Maximum Stopping Distance—Metres)									
Up to 16 000	0.3 (0.9)	1.5 (4.5)	2.9 (8.7)	5.2 (15.6)	7.1 (21.3)	9.2 (27.6)	11.6 (34.8)	14.4 (43.2)	17.2 (51.6)	20.4 (61.2)
Over 16 000 to 32 000	—	—	—	6.6 (19.8)	9.2 (27.6)	12.2 (36.6)	15.5 (46.5)	19.3 (57.9)	23.5 (70.5)	28.1 (84.3)
Over 32 000 to 64 000	—	—	—	7.9 (23.7)	11.1 (33.3)	14.8 (44.4)	19.0 (57.0)	23.8 (68.4)	29.2 (87.6)	35.0 (105.0)
Over 64 000 to 127 000	—	—	—	9.1 (27.3)	12.9 (38.7)	17.4 (52.2)	22.5 (67.5)	28.3 (84.9)	34.8 (104.4)	41.9 (125.7)
Over 127 000	—	—	—	11.0 (33.0)	15.8 (47.4)	21.3 (63.9)	27.8 (83.4)	35.0 (105.0)	43.2 (129.6)	52.2 (156.6)

Brake Performance Requirements (U.S. Customary Units)

Machine Mass, lb	Machine Speed, mph											
	4	6	8	10	12	14	16	18	20	22	24	26
	Service Brake Maximum Stopping Distance—Feet (Emergency Brake Maximum Stopping Distance—Feet)											
Up to 36 000	2 (6.0)	5 (15.0)	8 (24.0)	15 (45)	20 (60)	25 (75)	31 (93)	38 (114)	45 (135)	53 (159)	61 (183)	70 (212)
Over 36 000 up to 70 000	—	—	—	19 (57)	25 (75)	33 (99)	41 (123)	51 (153)	61 (183)	72 (216)	84 (252)	97 (292)
Over 70 000 up to 140 000	—	—	—	22 (66)	31 (93)	40 (120)	50 (150)	62 (186)	75 (225)	89 (267)	105 (315)	121 (364)
Over 140 000 to 280 000	—	—	—	26 (78)	36 (108)	47 (141)	60 (180)	74 (222)	89 (267)	107 (321)	125 (375)	145 (435)
Over 280 000	—	—	—	31 (93)	43 (129)	57 (171)	73 (219)	91 (273)	111 (333)	132 (396)	156 (468)	181 (521)