

Issued 1954-12
Revised 2003-09

Superseding J873 FEB95

Drag Force Test Procedure for Construction, Forestry, and Industrial Machines

- 1. Scope**—This SAE Standard establishes a test method to measure drag force of self-propelled, as well as towed, construction, forestry, and industrial machines, with or without payload, as listed in SAE J/ISO 6165 and J1116.

Drag force is measured as a function of travel speed.

2. References

- 2.1 Applicable Publications**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

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

SAE J1057—Identification Terminology of Earthmoving Machines

SAE J1116—Categories of Off-Road Self-Propelled Work Machines

- 3. Definitions**—For the purpose of this document, the following definitions apply:

3.1 Travel Speed—The actual machine velocity expressed in kilometers per hour (km/h).

3.2 Test Time—The time taken to cover the test distance, or duration of the test run, expressed in seconds (s).

3.3 Test Distance—The distance traveled by the test machine during the test time, expressed in meters (m).

3.4 Machine Mass—The mass of the machine as tested. It shall include the operator, a full tank of fuel, and all fluid compartments at their specified level; expressed in kilograms (kg).

3.5 Tire Pressure—Air pressure in the machine tires, as tested, expressed in kilopascals (kPa).

3.6 Atmospheric Humidity—Measured as the difference between the wet bulb temperature and dry bulb temperature expressed in degrees Celsius (°C). The measurement is to be taken at a point in time of the test to be reasonably representative of the conditions during all test runs.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2003 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:

Tel: 877-606-7323 (inside USA and Canada)

Tel: 724-776-4970 (outside USA)

Fax: 724-776-0790

Email: custsvc@sae.org

<http://www.sae.org>

SAE WEB ADDRESS:

- 3.7 Drag Force**—The combined rolling resistance and internal frictions that resist movement of a machine. It is determined by measuring the towing force required to maintain a specified travel speed. It is reported in kilonewtons (kN).
- 3.8 Towing Force**—The horizontal force measured with a load cell between the towing machine and the test machine.
- 3.9 Tow Hitch**—The part of the machine used for attaching the towing machine. For some machines not so equipped, this may have to be added for test purposes.
- 3.10 Towing Machine**—A machine capable of towing the test machine for a sustained distance maintaining constant test speeds.

4. Test Track

4.1 Layout—The test track shall be a straight, flat surface prepared:

- a. To minimize rolling resistance of the test machine without loss of traction of the towing machine.
- b. With a recommended testing length of 100 m with approaches of such length that speed and load are stabilized before entering the test section. Sufficient turning areas shall be provided at both ends.
- c. With a recommended grade of less than 0.5%. Where the grade exceeds 0.5%, runs shall be taken in both directions and the results averaged.
- d. With a crown slope from centerline to shoulder of less than 3%.

4.2 Surface Conditions

4.2.1 RUBBER-TIRED MACHINES—For machines equipped with rubber tires, the surface shall be, in the order of preference, clean, dry:

- a. Concrete—The surface shall have a uniform rough texture. Sealing material in any expansion joint shall be maintained flush or below the surface.
- b. Bituminous—Asphalt or asphaltic concrete.

4.2.2 CRAWLERS AND STEEL-WHEELED MACHINES—For crawlers or steel-wheeled machines, test courses of compacted earth shall be used. Such surfaces shall be maintained to be adequately drained, free of ruts, and substantially free of loose material.

4.2.3 ALTERNATIVE SURFACES—The test may be conducted on any other type of surface if required for specific test purposes. The nature of the surface shall be reported.

5. Apparatus

5.1 Towing Machine

5.2 Means to measure and record the following Table 1:

TABLE 1—ACCURACY OF MEASUREMENTS

	Accuracy
Time	±0.2 s
Distance	±0.5%
Towing Force	±1.0%
Machine Mass	±1.5%
Tire Pressure	±3.0%
Temperature	±1 °C
Wind Velocity	±2.5 km/h

6. Preparation for Test

6.1 Inspect test machine to verify:

- a. All mechanical adjustments (brakes, clutches, track tensions, etc.) meet manufacturer's operating specifications.
- b. Fluids and lubricants are as specified by the manufacturer.
- c. Fuel tank is filled to capacity.

6.2 Add payload, ballast, and/or attachments as required.

6.3 Adjust tire pressure as specified by the manufacturer.

6.4 Weigh the machine with operator in the operating position to obtain the total mass and the load distribution per axle or track.

6.5 Connect the test machine to the towing machine by means of tow hitch and tensile load cell.

6.6 If the test machine has a steerable front axle, a bridle hitch or other means may be necessary to maintain directional control.

6.7 Record data as shown in Figure 1.

7. Procedure

7.1 Prior to recording test data, the machine shall be operated until temperatures of fluids in all fluid compartments are in the operating range.

7.2 For self-propelled machines, the engine shall be functionally disconnected from the drivetrain by such means as disengaging master clutch, placing transmission in neutral, etc. The disengagement shall be accomplished by means of operator controls. If possible, drivetrain components which contribute to normal machine drag force shall remain engaged. Condition of various drivetrain components shall be recorded.

7.3 While traveling the test distance in the desired gear at constant speed of a specific test run, record:

- a. Time
- b. Distance
- c. Towing force

The time and distance of recorded test runs should be sufficient to achieve the desired accuracy. The average of two runs (one in each direction) should be used in reporting machine performance at each selected speed or pull.

A constant ground speed must be maintained throughout the entire test course.

Test shall not be reported for which wind velocity (in any direction) exceeds 24 km/h.

7.4 Test travel speeds shall not exceed the safety limitations of the track or machines. Usually, the travel speeds are less than 20 km/h. In the absence of a maximum tow speed specified by the manufacturer, the test speed of a self-propelled machine should not exceed the maximum speed obtainable when operated under its own power.

7.5 The travel speed, V , may be calculated from Equation 1:

$$V = \frac{d}{t} \quad (\text{Eq. 1})$$

where:

- d = Travel test distance, in meters
- t = Time to travel test distance, in seconds (to the nearest 0.1 s)
- V = Machine travel speed in meters/second

8. Test results shall be presented as shown in the data sheets of Figure 1.

9. Notes

9.1 **Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE OFF-ROAD MACHINERY TECHNICAL COMMITTEE SC12—
MACHINE TEST PROCEDURES