SAE The Engineering Resource For Advancing Mobility®

A Product of the
Cooperative Engineering Program

SAE J873 FEB86

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

SAE Standard
Revised February 1986

Submitted for Recognition as
an American National Standard

RATIONALE:

Consideration for changes to this document were made during a five year review. The first efforts at modifications were directed toward better definition of the test conditions and procedures. Later a complete rewrite was initiated so that the format of the document would conform to that of J872 - Reserve Tractive Ability Test Code.

Changes to the content of the document include:

1. A definition of the test site in Section 3 with such specifics as:
   a. Minimum length of the track at 100M.
   b. Overall grade of the track within 5%.
   c. The track crown within 3%.
   d. Recommended track surfaces for different machine types.
2. Test machine preparation more clearly defined in Section 5.
3. A specification for fluid temperatures to be at operating levels (Section 6.1).
4. A specification on the condition of the drive train components (Section 6.2).

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J1057, Identification Terminology of Earthmoving Machines

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

APPLICATION:

This SAE Standard specifies a test method to measure drag loss of self-propelled, as well as towed, construction, forestry, and industrial machines, with or without payload, as listed in SAE J1057 and J1116.

COMMITTEE COMPOSITION:

DEVELOPED BY SUBCOMMITTEE 12, MACHINE TEST PROCEDURES:

W. C. Jackson, Evans, Charles & Associates, Inc., Las Cruces, NM - Chairman
D. J. Pankow, Clark Equip. Co., Gwinner, ND - Vice Chairman
D. C. Ager, Deere & Co., Dubuque, IA
D. M. Anderson, J. I. Case Company, Terre Haute, IN
M. M. D'Jivre, Ontario Ministry of Labour, London, Ontario, Canada
J. L. Dahle, Woodward Associates, Inc., San Diego, CA
H. C. Davis, Merritt Cases, Inc., Redlands, CA

SUBCOMMITTEE 12 (Continued):

G. W. Douglas, Brownsburg, IN
A. L. Freedy, Caterpillar Tractor Co., Aurora, IL
W. O. Gipp, Racine, WI
D. W. Hadden, Lanham, MD
J. T. Janas, Clark Michigan Company, Benton Harbor, MI
M. L. Johnson, Caterpillar Tractor Co., Peoria, IL
R. A. Kluver, Palm Industries, Inc., Litchfield, MN
D. A. Lockie, Saf-T-Cab, Inc., Fresno, CA
D. J. Nelson, Weldco - Beales, Coquitlam, B.C., Canada
J. R. Prosek, Sr., Du Page Engrg. Services, Inc., Glen Ellyn, IL
G. C. Randall, Ford Motor Co., Troy, MI
W. L. Renken, WABCO C.M.E.G., Peoria, IL
K. W. Richter, Ingersoll-Rand Co., Shippensburg, PA
A. P. Schutte, Dresser Industries, Inc., Libertyville, IL
L. E. Spencer, J. I. Case Co., Burlington, IA
G. A. Stangl, Charles Machine Works, Inc., Perry, OK
S. A. Swan, Bureau of Mines, Minneapolis, MN
J. W. Zurek, Dresser Industries, Inc., Libertyville, IL

SPONSORED BY THE OFF-ROAD MACHINERY TECHNICAL COMMITTEE:

L. E. Miller, Davenport, IA - Chairman
W. L. Black, Clark Michigan Co., Buchanan, MI - Vice Chairman
G. R. Bailey, Bailey Marketing Inc., Crystal Lake, IL
W. F. Busbey, Caterpillar Tractor Co., Decatur, IL
J. B. Codlin, Spring Field, IL
L. W. G. Collins, Deere & Co., Dubuque, IA
W. L. Daniels, Sr., B. F. Goodrich Co., Bloomington, IN
D. W. Driscol, Cummins Eng. Co., Inc., Columbus, IN
B. Gill, American Honda Motor Co., Inc., Gardena, CA
T. O. Goodney, Platteville, WI
F. A. Green, GMC, La Grange, IL
J. H. Hyler, Peoria, IL
R. B. Janvrin, Fluid Controls Inc., Easley, SC
K. A. Julian, Julian Elec. Service & Engrg. Inc., Westmont, IL
P. L. Kelsey, Marathon LeTourneau Co., Longview, TX
L. B. Klöpfer, Budd Canada Inc., Winnipeg, Manitoba, Canada
A. D. Lewis, Sparta, NJ
M. E. Moore, Caterpillar Tractor Co., Peoria, IL
R. J. Nelissen, Deere & Co., Dubuque, IA
D. Oldenburg, Caterpillar Tractor Co., Aurora, IL
J. E. Page, Harnischfeger Corporation, Escanaba, MI
J. T. Parrett, St. Joseph, MI
S. P. Pertzsch, Harley-Davidson Motor Co., Milwaukee, WI
G. C. Randall, Ford Motor Co., Troy, MI
P. D. Redenbarger, Flotec Inc., Indianapolis, IN
G. H. Ritterbusch, Caterpillar Tractor Co., Peoria, IL
J. C. Skroski, J. I. Case Co., Racine, WI
G. A. Stangl, Charles Machine Works, Inc., Perry, OK
D. R. Thomas, Dresser Industries Inc., Peoria, IL

SAE The Engineering Resource For Advancing Mobility®

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

OFF-HIGHWAY MACHINERY STANDARD

Submitted for recognition as an American National Standard

SAE J873

Issued Dec. 1954
Revised Feb. 1986

Supersedes J873 APR80

DRAG FORCE TEST PROCEDURE FOR CONSTRUCTION, FORESTRY, AND INDUSTRIAL MACHINES

1. SCOPE: This SAE Standard specifies a test method to measure drag loss of self-propelled, as well as towed, construction, forestry and industrial machines, with or without payload, as listed in SAE J1057 and J1116.

   Drag force is measured as a function of travel speed.

2. DEFINITIONS: For the purposes of this SAE Standard, the following definitions apply:

2.1 Travel Speed: The actual machine velocity expressed in meters per second (m/s), or kilometers per hour (km/h) or feet per second (ft/s) or miles per hour (mph).

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

2.3 Test Distance: The distance traveled by the test machine during the test time, expressed in meters (m) or feet (ft).

2.4 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) or pounds (lb).

2.5 Tire Pressure: Air pressure in the machine tires, as tested, expressed in kilopascals (kPa) or pounds per square inch (psi).

2.6 Ambient Air Temperature/Relative Humidity: Wet bulb and dry bulb readings which are recorded during the test, expressed in degrees Celsius (°C) or degrees Fahrenheit (°F).

2.7 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) or pounds force (lbf).

2.8 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.

2.9 Towing Machine: A machine capable of towing the test machine for a sustained distance maintaining constant test speeds.

3. TEST SITE: The test track shall be a straight, level surface prepared to provide desired conditions of traction with a minimum of rolling resistance.

3.1 Recommended Minimum Length: The recommended minimum length is 100 m (330 ft) with approaches of such length that speed and load can be stabilized before entering the test section. Turning areas shall be provided at both ends of the track with sufficient room for the test train to turn easily.

3.2 Grade: The grade shall be less than 0.5%. If testing is conducted on a site with a grade more than 0.5%, runs shall be taken in both directions and the results averaged.

The crown slope from centerline to shoulder shall be less than 3%.

3.3 Surface:

3.3.1 Rubber-Tired Machines: For machines equipped with rubber tires, the surface shall be in order of preference:

3.3.1.1 Concrete: The surface shall have a uniform rough texture. It should have a minimum of expansion joints. Sealing material in the expansion joints shall be maintained flush or below the surface. It shall be dry and clean.

3.3.1.2 Bituminous: These materials are generally known as asphalt or asphaltic concrete.

3.3.2 Crawlers and Steel-Wheeled Machines: For crawlers or steel-wheeled machines, test courses of earth shall be used. These earthen surfaces shall be well packed and substantially free of loose material. This requires a soil that is cohesive when properly moistened and compacted. Scarifying, watering, grading and compacting equipment is needed for track preparation.

3.3.3 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.

4. APPARATUS:

4.1 Towing Machine:

4.2 Means to Measure and Record the Following:

	Accuracy
- Time	± 0.2 s
- Distance	± 0.5 %
- Pull	± 1.0 %
- Machine Mass	± 1.5 %
- Tire Pressure	± 3.0 %
- Temperature - Wet & Dry Bulb	± 1°C (± 1.8°F)
- Wind Velocity	± 1.5 mph

5. PREPARATION FOR TEST:

5.1 Carry out a service check on the machine prior to testing to ensure that:

a) all mechanical adjustments are as recommended by the manufacturer (brakes, clutches, etc.).

b) fuel, lubricants, and coolant are as specified by the manufacturer.

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

5.3 Adjust tire pressures as specified by the manufacturer.

5.4 Weigh the machine and obtain total mass and distribution on drive wheels with the operator in position on the seat and a full fuel tank.

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

5.6 The track tension should be adjusted to manufacturer's specification.

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

5.8 Record general data as shown in Table 1.

6. PROCEDURE:

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

6.2 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 loss shall remain engaged. Condition of various drivetrain components shall be recorded.

6.3 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.

Test shall not be reported for which wind velocity (in any direction) exceeds 15 mph.

6.4 Tests should be limited to travel speeds that can be safely obtained under the given conditions, usually less than 20 km/h (12 mph). Extra precautions must be observed for high speed runs.

6.5 The travel speed, V, may be calculated from the following formula:

$$V = \frac{d}{t}$$

where

d is the travel test distance, in meters (feet) (miles),

t is the time to travel test distance, in seconds (to the nearest 0.1 s),

V is the machine travel speed in meters/second (feet/second) (miles/hour).

7. TEST RESULTS:

7.1 Test results shall be presented as shown in the data sheets of Table 1.

7.2 The drag force is the measured towing force for a given travel speed.