



Designation: D 3233 – 93 (Reapproved 1998)

An American National Standard

Standard Test Methods for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Pin and Vee Block Methods)¹

This standard is issued under the fixed designation D 3233; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover two procedures for making a preliminary evaluation of the load-carrying properties of fluid lubricants by means of the Falex Pin and Vee Block Test Machine.

NOTE 1—Additional information can be found in Appendix X1 regarding coefficient of friction, load gage conversions, and load gage calibration curve.

1.2 The values stated in SI units are to be regarded as standard. Because the equipment used in these test methods is available only in inch-pound units, the SI units are omitted when referring to the equipment and the test specimens.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

B 16 Specification for Free-Cutting Brass, Rod, Bar, and Shapes for Use in Screw Machines²

D 2670 Test Method for Measuring Wear Properties of Fluid Lubricants (Falex Pen and Vee Block Method)³

D 2783 Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)³

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *actual gage load, n* —the value obtained from the gage while running the test and before any corrections are made.

3.1.1.1 *Discussion*—This gage reading is irrespective of the particular gage used, and corrections are made by comparison

to a standard reference.

3.1.2 *direct load, n* —that which is applied linearly, bisecting the angle of the vee block corrected to either the 800 or 3000-lbf gage reference.

3.1.2.1 *Discussion*—This load is equivalent to the true load times the $\cos 42^\circ$.

3.1.3 *true load, n* —the sum of the applied forces normal to the tangents of contact between the faces of one vee block and the journal pin corrected to the 4500 lbf gage reference line.

3.1.4 *true load failure value, n* —the true load at which the lubricant tested can no longer support the applied load resulting in either test pin or shear pin breakage, or inability to maintain or increase load.

3.1.4.1 *Discussion*—This value is also referred to as the limit of extreme pressure.

4. Summary of Test Methods

4.1 Both test methods consist of running a rotating steel journal at 290 ± 10 rpm against two stationary V-blocks immersed in the lubricant sample. Load is applied to the V-blocks by a ratchet mechanism. In Test Method A (Note 1), increasing load is applied continuously. In Test Method B (Note 1), load is applied in 250-lbf (1112-N) increments with load maintained constant for 1 min at each load increment. In both methods the load-fail value obtained is the criteria for level of load-carrying properties. Both methods require calibration of the load gage and reporting of test results as true (corrected) loads rather than actual gage loads.

NOTE 2—Test Method A is referred to as the Falex Run-Up Test. Test Method B is referred to as the Falex One-Minute Step Test.

5. Significance and Use

5.1 Evaluations by both test methods differentiate between fluids having low, medium, and high levels of extreme-pressure properties. The user should establish any correlation between results by either method and service performance.

NOTE 3—Relative ratings by both test methods on the reference fluids covered in Table 1 and Table 2 are in good general agreement with four-ball weld-point relative ratings obtained on these same reference fluids, covered in Test Method D 2783.

¹ These test methods are under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and are the direct responsibility of Subcommittee D02.01 on Industrial Lubricants.

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² *Annual Book of ASTM Standards*, Vol 02.01.

³ *Annual Book of ASTM Standards*, Vol 05.01.



TABLE 1 Results of Cooperative Tests on Reference Fluids L-XI-1-2-A, B, C, D, E^A TEST METHOD A

Laboratory	Test	L-XI-1-2-A Fail Load, lbf		L-XI-1-2-B Fail Load, lbf		L-XI-1-2-C Fail Load, lbf		L-XI-1-2-D Fail Load, lbf		L-XI-1-2-E Fail Load, lbf	
		Gage	True	Gage	True	Gage	True	Gage	True	Gage	True
A	1	1200	840	1200	840	4500 +	4100 +	4300	3950	2600	2100
	2	1275	920	1275	920	4500 +	4100 +	4500 +	4100 +	2400	1925
B	1	800	860	1000	1050	4500 +	4250 +	4100	3900	2050	2050
	2	850	900	950	1025	4500 +	4250 +	4300	4100	1950	1950
C	1	725	990	775	1020	4500 +	3200 +	3950	2900	1350	1460
	2	650	910	750	980	4500 +	3200 +	4100	3000	1300	1430
D	1	1400	1050	1100	770	4500 +	3500 +	4500 +	3500 +	2900	2150
	2	1400	1050	1250	900	4500 +	3500 +	4500 +	3500 +	2650	1975
E	1	825	900	1000	1060	4450	4500 +	4100	4475	1825	1970
	2	750	820	925	1000	4450	4500 +	4150	4500	1825	1970
F	1	1000 ^B	920 ^B	1000	800	4500 +	4500 +	3500	4500	1850	1900
	2	990 ^B	910 ^B	1050	850	4500 +	4500 +	2900	3510	1720	1720
G	1	800	900	690	800	4000	4275	3325	3625	1430	1600
	2	700	800	660	750	3750	4000	3150	3450	1500	1675
H	1	700	700	1000	1000	4500 +	4500 +	3750	3750	1900	1900
	2	700	700	1000	1000	4500 +	4500 +	4000	4000	1650	1650
I	1	750	600	1250	1000	4500 +	3750 +	4500 +	3750 +	1750	1450
	2	750	600	1000	800	4500 +	3750 +	4500 +	3750 +	1750	1450
Min Avg			600		775				2950 ^C		1445
Max Avg			1050		1037				4488 ^C		2063
Grand Avg			854		920				3809 ^C		1796
		Repeatability $s = 0.0624$ $r = 0.179$ (TL) ^D				Reproducibility $S = 0.140$ $R = 0.402$ (TL) ^D					

^AReference fluids used and described in Test Method D 2783.

^BCalibration curves shifted.

^CSix laboratories.

^DTL = average true load, lbf, of sample tested.

6. Apparatus

6.1 *Falex Pin and Vee Block Test Machine*,⁴ illustrated in Fig. 1, Fig. 2, and Fig. 3, fitted with 4500-lbf (20 000-N) gage or 3000-lbf (13 350-N) gage.

6.2 *Required for Calibration:*

6.2.1 *Allen Screw*, with attached 10-mm Brinnell ball.⁵

6.2.2 *Back-Up Plug*.⁵

6.2.3 *Standard Test Coupon*,⁵ soft, annealed copper, Hb 37–39.

6.2.4 *Brinnell Microscope*, or equivalent.

6.2.5 *Timer*, graduated in seconds and minutes.

6.2.6 *Rule*, steel, 6-in. (approximately 150-mm) long.

7. Reagents and Materials

7.1 *Standard Coined-Blocks*,⁵ $96 \pm 1^\circ$ angle, AISI C-1137 steel, HRC 20 to 24, surface finish 5 to 10 μin . (1.3×10^{-7} to 2.5×10^{-7} m), rms.

7.2 *Standard Test Journals*,⁵ $\frac{1}{4}$ in. (6.35 mm) outside diameter by $\frac{1}{4}$ in. (31.75 mm) long, AISI 3135 steel, HRB 87

⁴ The Falex Pin and Vee Block Test Machine, available from the Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554 has been found satisfactory for this purpose. A new model of this machine has been available since 1983. Certain operating procedures are different for this new model. Consult instruction manual of machine for this information.

⁵ Available from Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554.

to 91 on a ground flat surface, surface finish 5 to 10 μin . (1.3×10^{-7} to 2.5×10^{-7} m) rms.

7.3 *Locking Pins*,⁵ $\frac{1}{2}$ H brass, conforming to Specification B 16.

7.4 *Solvent*, safe, nonfilming, nonchlorinated.

NOTE 4—Petroleum distillate and benzene, formerly used as solvents in this method, have been eliminated due to possible toxic effects. Each user should select a solvent that can meet applicable safety standards and still thoroughly clean the parts.

8. Preparation of Apparatus

8.1 *Cleaning:*

8.1.1 Thoroughly clean the V-blocks, test journals, lubricant cup, and supports for V-blocks and test journals by washing, successively, with solvent selected in 7.4. Dry the V-blocks, test journals, lubricant cup, and supports, by allowing the final solvent to evaporate in air.

8.1.2 After cleaning, handle the test pieces with care to prevent contamination. Particularly, avoid contact of fingers with mating surfaces of V-blocks and test journals.

8.2 *Assembly:*

8.2.1 Insert the test journal into the test shaft and secure with a new brass locking pin, as shown in Fig. 1 and Fig. 3.

8.2.2 Insert the V-blocks into the recesses of the loading device and swing the V-blocks inward to contact the journals.



TABLE 2 Results of Cooperative Tests on Reference Fluids L-XI-1-2-A, B, C, D, E^A TEST METHOD B

Laboratory	Test	L-XI-1-2-A Fail Load, lbf		L-XI-1-2-B Fail Load, lbf		L-XI-1-2-C Fail Load, lbf		L-XI-1-2-D Fail Load, lbf		L-XI-1-2-E Fail Load, lbf	
		Gage	True	Gage	True	Gage	True	Gage	True	Gage	True
A	1	1100	750	1400	1000	4150	3750	4350	4000	2750	2250
	2	1100	750	1400	1000	4350	4000	4150	3750	2200	1750
B	1	670	750	940	1000	4200	4000	3900	3750	2000	2000
	2	670	750	670	750	3900	3750	4200	4000	1750	1750
C	1	520	750	520	750	4100 +	3000 +	4100	3000	1750	1750
	2	520	750	790	1000	4100 +	3000 +	4100 +	3000 +	1750	1750
D	1	1600	1250	1080	750	4500 +	3500 +	4500 +	3500 +	3000	2250
	2	1600	1250	1080	750	4500 +	3500 +	4500 +	3500 +	3300	2500
E	1	700	750	925	1000	3850	4250	3850	4250	1380	1500
	2	700	750	925	1000	4150	4500	3650	4000	1850	2000
F	1	1075 ^B	1000 ^B	950	750	3350	4250	3350	4250	1925	2000
	2	1075 ^B	1000 ^B	950	750	3500	4500	3050	3750	1560	1500
G	1	660	750	660	750	3500	3750	3000	3250	1550	1750
	2	660	750	800	1000	3200	3500	2800	3000	1350	1500
H	1	750	750	1000	1000	3500	3500	4250	4250	1500	1500
	2	750	750	1000	1000	4000	4000	4000	4000	1750	1750
I	1	930	750	910	750	4400	3750	4400 +	3750 +	1800	1500
	2	930	750	910	750	4400	3750	4400 +	3750 +	1800	1500
Min Avg			750		750		3625 ^C		3125 ^D		1500
Max Avg			1250		1000		4375 ^C		4125 ^D		2375
Grand Avg			833		875		3932 ^C		3837 ^D		1846
Repeatability						Reproducibility					
$s = 0.0624$						$S = 0.137$					
$r = 0.179 \text{ (TL)}^E$						$R = 0.391 \text{ (TL)}^E$					

^AReference fluids used and described in Test Method D 2783.

^BCalibration curves shifted.

^CSeven laboratories.

^DSix laboratories.

^ETL = average true load, lbf, of sample tested.

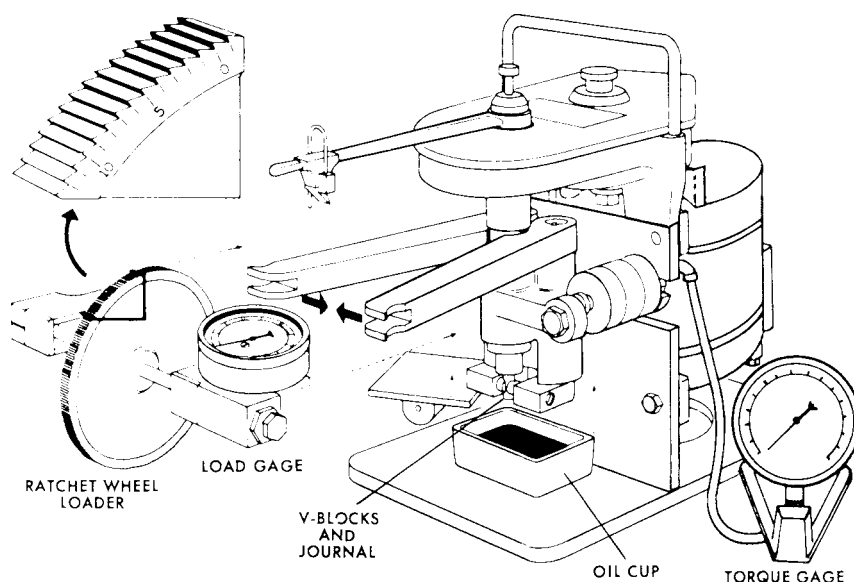


FIG. 1 Schematic Diagram of Falex Standard Pin and Vee Block Test Machine

that the V-grooves are aligned with the journal major axis, as shown in Fig. 1 and Fig. 3.

8.2.3 Place 60 mL of test lubricant in the lubricant cup and

raise the cup so that the V-blocks are immersed in the test lubricant. With highly viscous fluids open the jaws slightly to ensure that the wear surfaces are covered with the lubricant.