



# Standard Test Methods for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Pin and Vee Block Methods)<sup>1</sup>

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 ( $\epsilon$ ) 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/B 16M** Specification for Free-Cutting Brass, Rod, Bar and Shapes for Use in Screw Machines<sup>2</sup>

**D 2670** Test Method for Measuring Wear Properties of Fluid Lubricants (Falex Pen and Vee Block Method)<sup>3</sup>

**D 2783** Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)<sup>3</sup>

## 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.

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0 on Industrial Lubricants.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 05.01.

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  $290 \pm 10$  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

**TABLE 1 Results of Cooperative Tests on Reference Fluids L-XI-1-2-A, B, C, D, E<sup>A</sup>**  
(TEST METHOD A)

| Laboratory                                                  | Test | L-XI-1-2-A<br>Fail Load, lbf |                  | L-XI-1-2-B<br>Fail Load, lbf |      | L-XI-1-2-C<br>Fail Load, lbf |        | L-XI-1-2-D<br>Fail Load, lbf                                 |                   | L-XI-1-2-E<br>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 <sup>B</sup>            | 920 <sup>B</sup> | 1000                         | 800  | 4500 +                       | 4500 + | 3500                                                         | 4500              | 1850                         | 1900 |
|                                                             | 2    | 990 <sup>B</sup>             | 910 <sup>B</sup> | 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 <sup>C</sup> |                              | 1445 |
| Max Avg                                                     |      |                              | 1050             |                              | 1037 |                              |        |                                                              | 4488 <sup>C</sup> |                              | 2063 |
| Grand Avg                                                   |      |                              | 854              |                              | 920  |                              |        |                                                              | 3809 <sup>C</sup> |                              | 1796 |
| Repeatability<br>$s = 0.0624$<br>$r = 0.179 \text{ (TL)}^D$ |      |                              |                  |                              |      |                              |        | Reproducibility<br>$S = 0.140$<br>$R = 0.402 \text{ (TL)}^D$ |                   |                              |      |

<sup>A</sup> Reference fluids used and described in Test Method D 2783.

<sup>B</sup> Calibration curves shifted.

<sup>C</sup> Six laboratories.

<sup>D</sup> TL = average true load, lbf, of sample tested.

four-ball weld-point relative ratings obtained on these same reference fluids, covered in Test Method D 2783.

## 6. Apparatus

6.1 *Falex Pin and Vee Block Test Machine*,<sup>4</sup> 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.<sup>5</sup>

6.2.2 *Back-Up Plug*.<sup>5</sup>

6.2.3 *Standard Test Coupon*,<sup>5</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> Available from Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554.

## 7. Reagents and Materials

7.1 *Standard Coined-Blocks*,<sup>5</sup>  $96 \pm 1^\circ$  angle, AISI C-1137 steel, HRC 20 to 24, surface finish 5 to 10  $\mu\text{in}$ . ( $1.3 \times 10^{-7}$  to  $2.5 \times 10^{-7}$  m), rms.

7.2 *Standard Test Journals*,<sup>5</sup>  $\frac{1}{4}$  in. (6.35 mm) outside diameter by  $\frac{1}{4}$  in. (31.75 mm) long, AISI 3135 steel, HRB 87 to 91 on a ground flat surface, surface finish 5 to 10  $\mu\text{in}$ . ( $1.3 \times 10^{-7}$  to  $2.5 \times 10^{-7}$  m) rms.

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

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.



**TABLE 2 Results of Cooperative Tests on Reference Fluids L-XI-1-2-A, B, C, D, E<sup>A</sup>  
(TEST METHOD B)**

| Labora-<br>tory            | Test | L-XI-1-2-A<br>Fail Load, lbf |                   | L-XI-1-2-B<br>Fail Load, lbf |      | L-XI-1-2-C<br>Fail Load, lbf |                   | L-XI-1-2-D<br>Fail Load, lbf |                   | L-XI-1-2-E<br>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 <sup>B</sup>            | 1000 <sup>B</sup> | 950                          | 750  | 3350                         | 4250              | 3350                         | 4250              | 1925                         | 2000 |
|                            | 2    | 1075 <sup>B</sup>            | 1000 <sup>B</sup> | 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 <sup>C</sup> |                              | 3125 <sup>D</sup> |                              | 1500 |
| Max Avg                    |      |                              | 1250              |                              | 1000 |                              | 4375 <sup>C</sup> |                              | 4125 <sup>D</sup> |                              | 2375 |
| Grand Avg                  |      |                              | 833               |                              | 875  |                              | 3932 <sup>C</sup> |                              | 3837 <sup>D</sup> |                              | 1846 |
| Repeatability              |      |                              |                   |                              |      | Reproducibility              |                   |                              |                   |                              |      |
| $s = 0.0624$               |      |                              |                   |                              |      | $S = 0.137$                  |                   |                              |                   |                              |      |
| $r = 0.179 \text{ (TL)}^E$ |      |                              |                   |                              |      | $R = 0.391 \text{ (TL)}^E$   |                   |                              |                   |                              |      |

<sup>A</sup> Reference fluids used and described in Test Method D 2783.

<sup>B</sup> Calibration curves shifted.

<sup>C</sup> Seven laboratories.

<sup>D</sup> Six laboratories.

<sup>E</sup> TL = average true load, lbf, of sample tested.

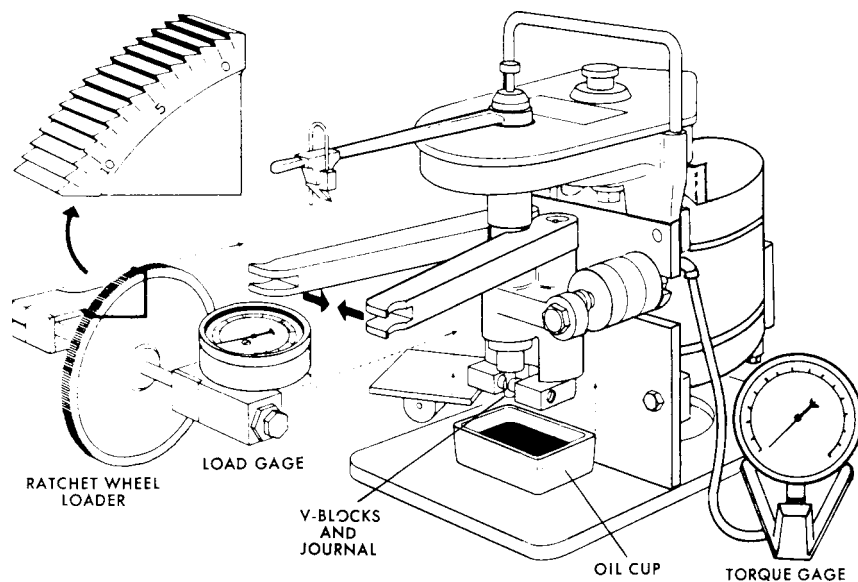


**FIG. 1 Schematic Diagram of Falex Standard Pin and Vee Block Test Machine**