

MIL-H-5606A

21 FEBRUARY 1957

SUPERSEDING

MIL-O-5606

31 JANUARY 1950

MILITARY SPECIFICATION

HYDRAULIC FLUID, PETROLEUM BASE,  
AIRCRAFT AND ORDNANCE

*This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.*

1. SCOPE

1.1 This specification covers the general requirements for petroleum base hydraulic oil. This oil is identified by NATO symbol H-515.

Fuels, and Related  
Products; Methods  
of Testing

MILITARY

MIL-STD-105 — Sampling Procedures  
and Tables for In-  
spection by Attri-  
butes

MIL-STD-290 — Packaging, Packing,  
and Marking of Pe-  
troleum Products

2. APPLICABLE DOCUMENTS

2.1 The following specifications and stand-  
ards, of the issue in effect on date of invi-  
tation for bids, form a part of the specifi-  
cation:

SPECIFICATIONS

FEDERAL

TT-T-656 — Tricresyl Phosphate

MILITARY

MIL-F-5504 — Filters, Hydraulic,  
MIL-F-5602 Aircraft Fluid; Ref-  
erence, Shear Sta-  
bility

(Copies of specifications, standards, drawings, and  
publication required by contractors in connection  
with specific procurement functions should be ob-  
tained from the procuring activity or as directed by  
the contracting officer.)

3. REQUIREMENTS

3.1 Qualification. The oil furnished under  
this specification shall be a product which  
has been tested and has passed the qualifica-  
tion tests specified herein.

3.2 Materials. The oil shall consist of petro-  
leum products with approved additive ma-  
terials to improve the viscosity temperature

STANDARDS

FEDERAL

Fed. Test  
Method Std.  
No. 791 — Lubricants, Liquid

FSC 9150

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characteristics and resistance to oxidation of the finished product. Tricresyl phosphate in the amount of  $0.5 \pm 0.1$  percent by weight shall be used as the antiwear agent.

**3.3 Petroleum Base Stock Requirements.** The properties of the petroleum base stock used in compounding the finished oil, before the addition of any other ingredients required herein, shall be as specified in table I.

TABLE I  
Properties of Petroleum Base Stock

Property	Value
Pour Point (max) <sup>1</sup>	-59.4° C (-75.0° F)
Flash Point (min)	93.3° C (200.0° F)
Acid or Base No. (max)	0.10
Precipitation No.	0

<sup>1</sup> Pour point depressant materials shall not be used.

**3.3.1 Specific Gravity.** The specific gravity of the base stock shall be determined but shall not be limited. Samples of base stock submitted for acceptance tests shall not vary by more than  $\pm 0.008$  at 15.6° C/15.6° C (60.0° F) from the specific gravity of the original sample submitted for qualification tests.

**3.3.2 Color of Base Oil.** The color of the undyed base oil shall be not darker than Number 1 ASTM Union Colorimeter when tested as specified in 4.4.1.

### 3.4 Additive Materials.

**3.4.1 Viscosity — Temperature Coefficient Improvers.** Approved polymeric materials may be added to the base petroleum oil in quantities not to exceed 10 percent by weight of active ingredient in order to adjust the viscosity of the finished fluid to the values specified in 3.5.

**3.4.2 Oxidation Inhibitors.** Approved oxidation inhibitors shall be added to the blend oil in quantities not to exceed 2 percent by weight.

**3.4 Antiwear Agent.** The tricresyl phos-

phate shall conform to the requirements of Specification TT-T-656 with the added requirement that the free phenol content of the TCP shall be limited to a maximum of 0.05 percent by weight when tested as specified in 4.4.6.

**3.5 Finished Oil.** The properties of the finished oil shall be as specified in table II and in 3.5.1 through 3.5.7.

TABLE II  
Properties of Finished Oil

Property	Value
Viscosity in centistokes at 54.4° C (130° F) (min)	10.0
Viscosity in centistokes at -40° C (-40° F) (max)	500
Pour point (max)	-59.4° C (-75.0° F)
Flash point (min)	93.3° C (200.0° F)
Precipitation No.	0
Acid or base No. (max)	0.20

<sup>1</sup> Pour point depressant materials shall not be used.

**3.5.1 Color.** The oil shall be clear and transparent, and shall contain red dye in concentration not greater than 1 part of dye per 10,000 parts of oil by weight. There shall be no readily discernible difference in the color of the finished oil and the standard color when tested as set forth in 4.4.2.

### 3.5.2 Corrosion and Oxidation Stability.

**3.5.2.1 Corrosion.** The change in weight of steel, aluminum alloy, magnesium alloy, and cadmium-plated steel when subjected to the action of the hydraulic oil for 168 hours at  $121.1^\circ \pm 1^\circ \text{ C}$  ( $250^\circ \pm 2^\circ \text{ F}$ ) shall not be greater than  $\pm 0.2$  milligrams per square centimeter of surface. The change in weight of copper under the same conditions shall be no greater than  $\pm 0.6$  milligram per square centimeter of surface. There shall be no pitting, etching, nor visible corrosion on the surface of the metals when viewed under magnification of 20 diameters. A slight stain on the surface of the copper shall be permitted, but dark brown, gray, or black stain shall be cause for rejection. A slight discoloration of the cadmium shall also be permitted.

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**3.5.2.2 Resistance to Oxidation.** The oil shall not have changed more than  $-5$  or  $+20$  percent from the original viscosity in centistokes at  $54.4^{\circ}\text{C}$  ( $130.0^{\circ}\text{F}$ ) after the oxidation-corrosion test. The acid or base number shall not have increased by more than  $0.20$  over the acid or base number of the original sample. There shall be no evidence of separation of insoluble materials nor gumming of the oil.

**3.5.3 Stability at Low Temperature.** The oil shall not gel, crystallize, solidify, nor show evidence of separation of insoluble material after being maintained at a temperature of  $-54^{\circ}\text{C}$  ( $-65^{\circ}\text{F}$ ) for 72 hours. At the end of the storage time, turbidity shall be not greater than that shown by the turbidity standard.

**3.5.4 Shear Stability.** When tested as specified in 4.4.1, the hydraulic oil shall meet the following requirements:

**3.5.4.1** The percentage viscosity decrease of the hydraulic oil, measured in centistokes at  $54.4^{\circ}\text{C}$  ( $130.0^{\circ}\text{F}$ ) and at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ), shall be no greater than the percentage viscosity decrease of the shear stability reference fluid, Specification MIL-F-5602, when the tests are run consecutively in the same apparatus with the pumping rate of the hydraulic oil under test at least as high as that of the reference fluid but not more than 10 percent higher.

**3.5.4.2** At the conclusion of the shear-stability test, the acid or base number shall not have increased over the original acid or base number by more than  $0.20$ .

**3.5.5 Swelling of Synthetic Rubber.** When tested as specified in 4.4.3, the volume increase of the standard synthetic rubber L by the test fluid shall be within the range of 19.0 to 26.5 percent.

**3.5.6 Evaporation.** When tested as specified in 4.4.4, the residue after evaporation shall be oily and shall not be hard nor tacky.

**3.5.7 Copper-Strip Corrosion.** When the oil is tested as specified in 4.4.5, the corrosion produced shall be less than No. 3 of the ASTM corrosion scale.

**3.6 Workmanship.** The oil shall contain no admixture of resins, rubber, soaps, gums, fatty oils, oxidized hydrocarbons, nor any other additive unless specifically approved by the qualifying activity. The oil shall be entirely homogeneous. The oil shall contain less than 0.005 percent water. At no time during the blending process nor any operations subsequent thereto shall the temperature of any of the components of the fluid, or the fluid itself, be greater than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ). Immediately before final packaging the oil shall be filtered through a 10 micron filter conforming to Specification MIL-F-5504.

#### 4. QUALITY ASSURANCE PROVISIONS

**4.1 Classification of Tests.** The inspection and testing of hydraulic oil shall be classified as follows:

**4.4.1 Qualification Tests.** Qualification tests are those tests accomplished on samples submitted for qualification as a satisfactory product.

**4.1.1.1 Qualification of Petroleum Base Stock.** Separate qualification tests shall be conducted for each petroleum base stock or blend of base stocks. Approval granted on hydraulic oil manufactured from one base stock shall not apply to oils manufactured from any other base stock.

**4.1.2 Acceptance Tests.** Acceptance tests shall be accomplished on material to be supplied under contract or order.

#### 4.2 Qualification Tests.

**4.2.1 Sampling Instructions.** Qualification test samples shall consist of 10 gallons of hydraulic oil, 1 gallon of the petroleum oil base stock before the addition of additive

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agents, 8 ounces of the additives used for improving the viscosity temperature coefficient, 8 ounces of tricresyl phosphate, and 1 ounce of the compound used for improving the oxidation stability. In the event that additives are supplied as concentrated solutions, an equivalent quantity of the solvent shall be furnished. Samples shall be forwarded to the activity specified in 6.4 and prominently identified by securely attached durable tags marked with the following information:

Sample for Qualification Test  
HYDRAULIC FLUID, PETROLEUM  
BASE, AIRCRAFT AND ORD-  
NANCE

Name of Ingredient (for ingredient  
material)

Product Code No.

Name of Manufacturer

Submitted by (name) (date) for Quali-  
fication tests in accordance with the  
requirements of Specification MIL-  
H-5606A under authorization (refer-  
ence authorizing letter).

4.2.1.1 Qualification samples shall be ac-  
companied by a certified test report contain-  
ing complete information as to the source  
and type of base stock and additive materials  
used, the formulation and composition of the  
finished oil, and laboratory data showing  
quantitative results of all tests required by  
this specification. Separate qualification tests  
shall be required for each base stock used.

4.2.1.2 *Formulation Sheets.* An example of  
a satisfactory form for the formulation sheet,  
indicating the percentage and nature of each  
ingredient, is as follows:

Petroleum oil base stock (composition)	percent
Viscosity index improver (mfr's name and No.)	percent
Tricresyl phosphate additive (mfr's name and No.)	percent
Oxidation inhibitor (mfr's name and No.)	percent

4.2.2 *Tests.* The qualification tests of hy-  
draulic oil shall consist of all the tests speci-  
fied under 4.4, "Test Methods."

4.3 *Acceptance Tests.* Acceptance tests  
shall consist of sampling tests only.

4.3.1 Inspection requirements shall be in  
accordance with Fed. Test Method Std. No.  
791, method 9601.

4.3.2 *Sampling Plan and Tests.* Except as  
provided for in 4.3.3, acceptance test samples  
shall be selected in accordance with Fed.  
Test Method Std. No. 791, method 8001, and  
shall be subjected to all of the tests described  
under 4.4, "Test Methods," except for the  
following:

	Paragraph No.
a. Corrosion and oxidation stability	4.4.1
b. Shear stability	4.4.1
c. Evaporation	4.4.4

4.3.2.1 The hydraulic oil may be subjected  
to any of the tests specified herein which the  
procuring activity considers necessary to  
determine conformance to the requirements  
of this specification.

4.3.3 *Sampling for Inspection of Filled  
Containers.* A random sample of filled con-  
tainers shall be selected from each lot in  
accordance with Standard MIL-STD-105 at  
Inspection Level II and Acceptance Quality  
Level (AQL) — 2.5 percent defective to  
verify compliance with all the stipulations of  
this specification regarding fill, closure,  
marking, and other requirements not involv-  
ing tests (see 4.4.7).

4.3.3.1 *MIL-STD-105.* When Standard  
MIL-STD-105 specifies an action by the  
Government, it shall, at the option of the  
Government, be performed either by the Gov-  
ernment or by the contractor under the  
supervision of the Government inspector.

4.3.4 *Rejection and Retest.* Failure of any  
sample of hydraulic oil to conform to any one



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of the requirements of this specification shall be cause for the rejection of the lot represented. Hydraulic oil which has been rejected may be reworked to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the inspector. Units rejected after retest shall not be resubmitted without the specific approval of the procuring activity.

#### 4.4 Test Methods.

4.4.1 The following tests shall be conducted in accordance with the applicable method given in Fed. Test Method Std. No. 791:

Test	Method No.
a. Pour point	201
b. Flash point	1103
c. Acid or base No.	5105
d. Precipitation No.	3101
e. Specific gravity	401
f. Color	102
g. Viscosity	305
h. Corrosion and oxidation stability	5308
i. Stability at low temperature	202
j. Shear stability of hydraulic oils	3471
k. Water by distillation	3001

4.4.2 *Color of Finished Oil.* The color of the hydraulic oil shall be compared with a standard sample prepared by adding one part of dye, National Aniline and Chemical Company "Oil, Red O" to 10,000 parts of an oil not darker than ASTM Number 1. The comparison shall be made in 4-ounce sample bottles using method 102 of Fed. Test Method Std. No. 791.

4.4.3 *Swelling of Synthetic Rubber.* The increase in volume of synthetic rubber due to the swelling action of the hydraulic fluid shall be determined in accordance with method 3603 of Fed. Test Method Std. No. 791

except that comparative tests using high- and low-swell reference fluids need not be performed. The swelling test shall be performed on three samples of standard synthetic rubber L (see 6.4) and the average of the three results shall be reported. The test shall not be valid if the values of the percentage of volume swell for the individual tests differ from each other by more than 5 percent.

4.4.4 *Evaporation.* A microscope slide shall be immersed in the hydraulic oil at room temperature. It shall then be removed and suspended by one end in an air oven at 65.6° C (150.0° F) for 4 hours. After removal of the slide and cooling to room temperature, the residual film shall be oily, and neither hard nor tacky.

4.4.5 *Copper-Strip Corrosion.* The test shall be conducted in accordance with method 5313 of Fed. Test Method Std. No. 791 except that time of test shall be increased from 3 to 72 hours.

4.4.6 *Free Phenol Content of Tricresyl Phosphate.* A 10g sample of the tricresyl phosphate shall be weighed and transferred to a 250 ml volumetric flask. Fifty ml of sodium hydroxide solution (2.5 percent) at 65° C (149° F) shall be added and the flask shaken vigorously for 3 minutes. This solution shall be diluted to 250 ml and filtered. A 100 ml portion shall then be pipetted into a 300 ml flask for titration. After the aliquot sample has been pipetted into the 300 ml flask, the 15 ml of sodium bromide-bromate solution (containing 10.09g of sodium bromide and 2.95g of sodium bromate per liter) shall be added from a burette, and then 5 ml of concentrated hydrochloric acid (sp gr 1.19). The hydrochloric acid shall be added quickly and the rubber stopper put in place immediately after which the flask shall be shaken and allowed to stand for 15 minutes. Ten ml of potassium iodide solution (6 percent) shall be added and the solution titrated with 0.05N sodium thiosulfate solution ( $\text{Na}_2\text{S}_2\text{O}_3$ ), using starch solution (1 percent) as an indicator. The starch solution shall be

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added near the end of the titration. The fading out of the blue color marks the end point of the titration. A blank titration shall

be run as above using the same reagents. The percentage of free phenols (cresol) shall be calculated as follows:

$$\frac{(\text{ml Na}_2\text{S}_2\text{O}_8 \text{ (blank)} - \text{ml Na}_2\text{S}_2\text{O}_8 \text{ (sample)}) \times \text{normality}^1 \times 4.50}{\text{Weight of Sample}} = \% \text{ free phenols}$$

<sup>1</sup> Normality of the sodium tetrathionate solution

4. *Inspection of Filled Containers.* Each sample filled container selected in accordance with 4.3.3 shall be examined for defects of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each sample filled container shall also be weighed to determine the amount of the contents. Any container in the sample having one or more defects or under required fill shall be rejected, and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of Standard MIL-STD-105, the lot represented by the sample shall be rejected. Rejected lots may be resubmitted for acceptance tests provided that the contractor has removed or repaired all non-conforming containers.

## 5. PREPARATION FOR DELIVERY

5.1 *Packaging and Packing.* The packaging and packing of the hydraulic oil shall be in accordance with Standard MIL-STD-290 except that the tops and bottoms of the hermetically sealed containers shall not be painted. The type and size of the containers shall be as specified by the procuring activity (see 6.2). All materials used in the construction of the containers shall be such as will not affect or be affected by the contained hydraulic oil. Before filling, all containers shall be thoroughly cleaned and inspected to insure absolute absence of dirt, corrosion products, water, or other materials which would contaminate or interfere with satisfactory operation of the hydraulic oil. The cleanliness of the containers shall be positive.

5.2 *Marking.* The marking of the hydraulic oil containers shall be in accordance with Standard MIL-STD-290. In addition to any

special marking required in the contract or order, the unit containers shall also be marked with the following information:

NATO Symbol H-515

INSTRUCTIONS: DESTROY THIS CONTAINER WHEN EMPTY. THIS OIL IS NOT INTERCHANGEABLE WITH HYDRAULIC FLUID; CASTOR OIL BASE (BLUE COLOR)

## 6. NOTES

6.1 *Intended use.* The hydraulic oil covered by this specification is intended for use in automatic pilots, shock absorbers, brakes, flap-control mechanisms, and other hydraulic systems using synthetic sealing material.

6.1.1 This fluid is not interchangeable with hydraulic fluid, castor oil base, Specification MIL-H-7644(USAF) nor hydraulic fluid, nonpetroleum base, automotive Specification VV-F-451.

6.2 *Ordering data.* Procurement documents should specify the following:

- Title, number, and date of this specification
- Type and size of containers
- Quantity
- Selection of applicable levels of packaging and packing.

6.2.1 The material should be purchased by volume, the unit being a U.S. gallon at 15.6° C (60° F). For Service purposes, the hydraulic oil will not be purchased in other than 1-quart or 1-gallon containers.

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**6.2.2 List of Qualified Products.** Products considered acceptable under this specification are listed in QPL-5606 and subsequent revisions thereto.

**6.3 Qualification.** With respect to products requiring qualification, awards will be made only for such products as have, prior to the bid opening date, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date.

**6.3.1** The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Commander, Wright Air Development Center, Attn: WCRTR-1, Wright-Patterson Air Force Base, Ohio.

**6.4** Samples of the standard synthetic rubber L for the test specified in 4.4.3 may be obtained from the Commander, Wright Air Development Center, Attn: WCRTR-3, Wright-Patterson Air Force Base, Ohio.

**6.5** Provisions of this specification are the subject of international standardization agreements. When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Office (DepSo) so that appropriate action may be taken respecting the international agreement concerned.

**Notice.** When Government drawings, specification or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

**Custodians:**

Army—Ordnance Corps  
Navy—Bureau of Aeronautics  
Air Force

**Other interest:**

International (See section 6.)  
Army—EQSigT  
Navy—ShOrMdMc

**Preparing activity:**

Air Force