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PERFORMANCE SPECIFICATION

HYDRAULIC FLUID, RUST INHIBITED, FIRE RESISTANT SYNTHETIC HYDROCARBON BASE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for two types of synthetic hydrocarbon base hydraulic fluids (see 6.2).

1.2 Types. The types of hydraulic fluid are as follows:

Type I	- Undyed and identified by Military symbol FRH and NATO Code No. H-544.
Type II	- Dyed red for aerospace use.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirement documents cited in sections 3 and 4 of this specification, whether or not they are listed.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-D/210, Warren, MI 48397-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 9150

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-H-5606	- Hydraulic Fluid, Petroleum Base; Aircraft; Missile and Ordnance.
MIL-PRF-6083	- Hydraulic Fluid, Petroleum Base for Preservation and Operation.
MIL-PRF-27601	- Hydraulic Fluid, Fire Resistant, Hydrogenated Polyalphaolefin Base, High Temperature, Flight Vehicle, Metric.
MIL-PRF-83282	- Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537.
MIL-PRF-87257	- Hydraulic Fluid, Fire Resistant, Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile.

STANDARDS

FEDERAL

FED-STD-791	- Lubricants, Liquid Fuels, and Related Products; Methods of Testing.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATIONS

BULLETIN

AF539	- Standard Elastomer Stocks.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D92	- Flash and Fire Points by Cleveland Open Cup (DoD adopted).
ASTM D97	- Pour Point of Petroleum Products (DoD adopted).
ASTM D130	- Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test (DoD adopted).
ASTM D329	- Acetone (DoD adopted).
ASTM D445	- Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity) (DoD adopted).
ASTM D664	- Acid Number of Petroleum Products by Potentiometric Tritration (DoD adopted).
ASTM D892	- Foaming Characteristics of Lubricating Oils (DoD adopted).
ASTM D972	- Evaporation Loss of Lubricating Greases and Oils (DoD adopted).
ASTM D1193	- Reagent Water (DoD adopted).
ASTM D1500	- ASTM Color of Petroleum Product (ASTM Color Scale) (DoD adopted).
ASTM D1744	- Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent (DoD adopted).
ASTM D1748	- Rust Protection by Metal Preservatives in the Humidity Cabinet (DoD adopted).
ASTM D2273	- Trace Sediment in Lubricating Oils (DoD adopted).
ASTM D4057	- Manual Sampling of Petroleum and Petroleum Products (DoD adopted).
ASTM D4172	- Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method) (DoD adopted).
ASTM D4177	- Automatic Sampling of Petroleum and Petroleum Products (DoD adopted).
ASTM D4898	- Standard Test Method for Insoluble Contamination of Hydraulic Fluids by Gravimetric Analysis (DoD adopted).
ASTM D5306	- Standard Test Method for Linear Propagating Rate of Lubricating Oils and Hydraulic Fluids.
ASTM E659	- Autoignition Temperature of Liquid Chemicals.

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The hydraulic fluid furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.1.1 and 6.3).

3.2 Materials. Unless otherwise specified herein, the chemical formula of the hydraulic fluid is the prerogative of the contractor as long as all articles submitted to the Government fully meet the operating, interface, support and ownership, and environmental requirements specified (see 4.3.2).

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.2.2 Hydraulic fluid. The hydraulic fluid shall consist of a synthetic hydrocarbon base stock (alpha-olefin polymer). Additives shall not include resins, gums, fatty oils, oxidized hydrocarbons, chlorine or silica. The concentration of red dye in the hydraulic fluid shall not exceed one part of dye per 10 000 parts of hydraulic fluid by weight.

3.3 Operating requirements.

3.3.1 Kinematic viscosity. The kinematic viscosity of the hydraulic fluid shall be as specified in table I (see 4.3.3.1).

TABLE I. Kinematic viscosity.

Temperature, °C	Kinematic viscosity, mm^2/s 1/
40	19.5, maximum
100	3.4, minimum
-40	2600, maximum

1/ mm^2/s = Square millimeters per second.

3.3.2 Trace sediment. The hydraulic fluid shall have a maximum trace sediment of 0.005 milliliter (mL) (see 4.3.3.2).

3.3.3 Water content. The hydraulic fluid shall have maximum water weight of 0.05 percent (%) (see 4.3.3.3).

3.3.4 Acid or base number. The hydraulic fluid shall have maximum acid or base number of 0.20 milligrams of potassium hydroxide per gram of hydraulic fluid (mg KOH/g) (see 4.3.3.4).

3.3.5 Bulk modulus. The isothermal secant bulk modulus of the hydraulic fluid shall be 1.379×10^6 kilopascals (kPa) minimum, at 40 degrees Celsius (°C), at pressures between 0 and 68 950 kPa (see 4.3.3.5).

3.3.6 Water sensitivity. The light transmittance of a water-treated sample of hydraulic fluid shall be a minimum of 90% (see 4.3.3.6).

3.3.7 Corrosion protection (humidity cabinet). The hydraulic fluid shall protect specially prepared steel test panels to the extent that no more than three corrosion dots, none of which exceed 1 millimeter (mm) in diameter, occur on any of the panels (see 4.3.3.7).

3.3.8 Corrosiveness (bimetallic couple). The hydraulic fluid shall not promote galvanic corrosion, in excess of three spots, on any one of the steel test disks covered with a brass clip (see 4.3.3.8).

3.3.9 Solid particle contamination.

3.3.9.1 Particle size. The number of solid contamination particles per 100 mL of the hydraulic fluid shall not be greater than the numbers specified in table II (see 4.3.3.9.1).

TABLE II. Particle size.

Particle size range, micrometers 1/	Maximum allowable number of particles
5-25	10 000
26-50	250
51-100	50
over 100	10

1/ Size is determined by the largest dimension of the particle.

3.3.9.2 Gravimetric method. The solid particle contamination of the hydraulic fluid shall not be greater than 0.5 mg/100 mL (see 4.3.3.9.2).

3.3.10 Foaming characteristics.

3.3.10.1 Foaming tendency. The foam volume of the hydraulic fluid shall not exceed 65 mL following any of the 5-minute blowing periods of the foaming characteristics test (see 4.3.3.10.1).

3.3.10.2 Foam stability. There shall be no foam remaining in the hydraulic fluid, in excess of a ring of bubbles around the edge of the test container, following any of the 10-minute settling periods of the foaming characteristics test (see 4.3.3.10.2).

3.3.11 Wear. During the wear test, the hydraulic fluid shall lubricate the steel balls such that the average scar diameters on the steel balls shall not exceed 0.30 mm if the test load is 147 Newtons (N), or 0.65 mm if the test load is 392 N (see 4.3.3.11).

3.3.12 High temperature - high pressure spray ignition. The hydraulic fluid, when sprayed and ignited, shall be self-extinguishing (see 4.3.3.12).

3.3.13 Linear flame propagation. The linear flame propagation rate of the hydraulic fluid shall not exceed 0.30 centimeters per second (cm/s) (see 4.3.3.13).

3.3.14 Specific gravity. The specific gravity of the hydraulic fluid samples submitted for conformance testing shall not vary more than ± 0.008 at 15.56°C/15.56°C from the specific gravity of the sample approved in qualification testing (see 4.3.3.14).

3.4 Interface requirements.

3.4.1 Corrosiveness and oxidation stability (metal protection).

3.4.1.1 Weight change of test specimens. The hydraulic fluid shall not produce corrosion or oxidation effects such that the weight change of the metal specimens, except for copper specimen, exceeds a gain or loss of 0.2 milligrams per square centimeter (mg/cm^2). For the copper specimen, the weight gain or loss shall not exceed 0.6 mg/cm^2 (see 4.3.4.1.1).

3.4.1.2 Appearance of test specimens. The hydraulic fluid shall not cause etching, pitting, or visible corrosion on the surface of the metal specimens, except for the copper specimen. Any corrosion produced on the surface of the copper specimen shall not be greater than No. 2 of ASTM D130 Copper Corrosion Standards (see 4.3.4.1.2).

3.4.1.3 Viscosity change. The viscosity of the oxidized hydraulic fluid at 40°C shall not change more than ±10% from the initial viscosity measured at 40°C (see 4.3.4.1.3).

3.4.1.4 Acid or base number change. The acid or base number of the oxidized hydraulic fluid shall not increase more than 0.30 mg KOH/g over the initial acid or base number (see 4.3.4.1.4).

3.4.1.5 Insoluble material. The oxidized hydraulic fluid shall exhibit no insoluble materials or gum when examined (see 4.3.4.1.5).

3.4.2 Swelling of synthetic rubber. Following immersion in the hydraulic fluid at a temperature of 70°C for 168 hours, standard synthetic rubber NBR-L, in accordance with (IAW) USAF Specification Bulletin 539, shall exhibit a percent volume change within the range of 15 to 25% (see 4.3.4.2).

3.4.3 Compatibility. The hydraulic fluid shall be compatible, in all concentrations, with each of the fluids approved under this specification, as well as hydraulic fluids conforming to MIL-H-5606, MIL-PRF-6083, MIL-PRF-83282 and MIL-PRF-87257 (see 4.3.4.3).

3.4.4 Color (type II only). Type II hydraulic fluid shall be dyed red. There shall be no readily discernible difference in color between the hydraulic fluid and a defined color test sample (see 4.3.4.4).

3.5 Support and ownership requirements.

3.5.1 Product identification. In addition to any special marking required in the contract or order, the unit containers for type I shall also be marked with the following (see 4.3.5.1):

"MILITARY SYMBOL FRH
NATO CODE NUMBER H-544

NOT TO BE USED FOR AIR APPLICATIONS"

Types I and II shall also be marked with the following:

"INSTRUCTIONS: THIS FLUID IS NOT INTERCHANGEABLE WITH ANY OTHER TYPE OR GRADE OF HYDRAULIC FLUID. IT IS COMPATIBLE WITH MIL-H-5606, MIL-PRF-6083, MIL-PRF-83282 AND MIL-PRF-87257."

Type II shall also be marked "NOT FOR GROUND EQUIPMENT USE".

3.5.2 Storage stability. Fully blended hydraulic fluid shall show neither separation of ingredients nor evidence of crystallization after 12 months of storage at 23.8 + 3°C. The blended product shall be clear and transparent when examined visually, and shall conform to all requirements specified herein, except solid particle contamination (see 4.3.5.2).

3.6 Environmental requirements.

3.6.1 Flash point. The minimum flash point of the hydraulic fluid shall be 218°C for type I, and 204°C for type II (see 4.3.6.1).

3.6.2 Fire point. The minimum fire point of the hydraulic fluid shall be 246°C (see 4.3.6.2).

3.6.3 Pour point. The maximum pour point of the hydraulic fluid shall be –54°C (see 4.3.6.3).

3.6.4 Evaporation loss. The maximum mass percent evaporation loss of the hydraulic fluid shall be 5% (see 4.3.6.4).

3.6.5 Autoignition temperature. The minimum autoignition temperature of the hydraulic fluid shall be 343°C (see 4.3.6.5)

3.6.6 Low temperature stability. The hydraulic fluid shall show no evidence of gelling, crystallization, solidification or separation of insoluble material when subjected to a temperature of -40°C for 72 hours (see 4.3.6.6).

4. VERIFICATION

4.1 Classification of inspection. The inspection conditions specified herein are classified as follows:

a. Qualification inspection (see 4.1.1).
b. Conformance inspection (see 4.1.2).

4.1.1 Qualification inspection. Qualification inspection shall consist of tests for all of the requirements specified in section 3 and may be conducted in any plant or laboratory approved by the qualifying activity.

4.1.2 Conformance inspection. Conformance tests shall consist of tests for all of the requirements specified in section 3 except the following:

a. Bulk modulus (see 3.3.5).
b. High temperature-high pressure spray ignition (see 3.3.12).
c. Linear flame propagation (see 3.3.13).
d. Corrosiveness and oxidation stability (see 3.4.1).
e. Compatibility (see 3.4.3).
f. Storage stability (see 3.5.2).

4.2 Sampling.

4.2.1 Sampling for examination of filled containers. Random samples of filled containers shall be taken from each packaged lot.

4.2.2 Sampling for tests (except particle size). Samples of hydraulic fluid for all tests except particle size shall be taken IAW ASTM D4057 or D4177.

4.2.3 Sampling for particle size test. Samples of hydraulic fluid for particle size test shall be taken containers (see 6.2) as specified in table III.

TABLE III. Sample for particle size.

Container size	Sample size, ml	Number of determinations per sample 1/
1 quart	100	1
1 gallon	200	2
5 gallon	300	3
55 gallon	600	6

1/ Each determination shall be made on 100-mL portions of the sample.

4.2.3.1 Sample for determination of solid particle contamination (gravimetric method). One sample shall be taken from the orifice of the filler during the first day that a packaging of a batch commences, for testing IAW 4.3.3.9.2.

4.3 Methods of qualification inspection. Qualification inspection shall consist of the tests for all of the requirements specified in section 3. Use reagent water conforming to the requirements for type III of ASTM D1193 and reagent-grade chemicals in all tests. Unless otherwise specified (see 6.2), run blank determinations and apply corrections when necessary.

4.3.1 Verification methods. The types of verification methods included in this section are visual inspection, measurement, sample tests, full scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously approved or previously qualified designs.

4.3.1.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures, to verify performance. See the contract for alternatives that replace verifications required by this specification.

4.3.2 Material requirements verification. To determine conformance to 3.2, the manufacturer shall certify that the hydraulic fluid is made from synthetic hydrocarbon base stock (alpha-olefin polymer); that any additives do not include resins, gums, fatty oils, oxidized hydrocarbons, chlorine or silica; and that the concentration of red dye does not exceed one part per 10 000 parts of hydraulic fluid by weight.

4.3.3 Operating requirements verification.

4.3.3.1 Kinematic viscosity. To determine conformance to 3.3.1, the hydraulic fluid shall be tested IAW ASTM D445 at each temperature listed in table I. The kinematic viscosity at each temperature shall be as specified in table I.

4.3.3.2 Trace sediment. To determine conformance to 3.3.2, the hydraulic fluid shall be tested IAW ASTM D2273, and shall exhibit a maximum trace sediment of 0.005 mL.

4.3.3.3 Water content. To determine conformance to 3.3.3, the hydraulic fluid shall be tested IAW ASTM D1744, and shall exhibit a maximum water weight of 0.05%.

4.3.3.4 Acid or base number. To determine conformance to 3.3.4, the hydraulic fluid shall be tested IAW ASTM D664, and shall exhibit a maximum acid or base number of 0.20 mg KOH/g.

4.3.3.5 Bulk modulus. To determine conformance to 3.3.5, the hydraulic fluid shall be tested IAW 4.3.3.5.1 and 4.3.3.5.2. The isothermal secant bulk modulus shall be a minimum of 1.379×10^6 kPa.

4.3.3.5.1 Apparatus. The test equipment referenced in MIL-PRF-27601 shall be used. The pycnometer volume-to-capillary diameter ratio shall be chosen to provide a precision of measurement for liquid density of ±2 parts in 10 000.

4.3.3.5.2 Procedure. Charge the pycnometer with candidate fluid to the top of the capillary at 40°C and atmospheric pressure. Insert the pycnometer in the high-pressure pycnometer housing so that the capillary tube is visible through the window of the pressure vessel and parallel to the outside vertical surfaces of the pressure vessel. Assemble the pressure vessel containing the pycnometer, place it in a 40°C constant-temperature bath, allow equilibrium to be reached, and take volume reading at atmospheric pressure. (Since the precision of the unit depends on visual readings, care must be taken to avoid errors due to parallax and distortion in the pressure vessel window and the walls of the constant-temperature bath.) Increase nitrogen pressure to a new level, and after a 1-hour soak, take a second reading. For any pressure range, the secant bulk modulus is defined by the following equation:

$$\text{Bulk modulus} = \frac{V\,\Delta P}{\Delta V + \Delta Vg}$$

Where: V is the original volume of fluid,
ΔV is the observed volume change due to ΔP increase in pressure,
ΔP is the pressure change between the two measurements in kPa, and
ΔVg is the correction factor.

The correction factor (ΔVg) considers the bulk modulus of glass in determining the true volume of the pycnometers at pressures above atmospheric. The bulk modulus of Pyrex glass is 3.28×10^7 kPa. Therefore:

$$\Delta Vg = \frac{V\,\Delta P}{3.28 \times 10^7}$$

4.3.3.6 Water sensitivity. To determine conformance to 3.3.6, the hydraulic fluid shall be tested IAW 4.3.3.6.1 and 4.3.3.6.2. The light transmittance of the water-treated hydraulic fluid shall be a minimum of 90%.

4.3.3.6.1 Preparation of test samples. Clean two 475-mL glass bottles with caps by washing with a detergent (Alconox or equivalent), rinsing with tap water, then water IAW Type III of ASTM D1193, then anhydrous isopropyl alcohol and finally filtered petroleum ether. After the petroleum ether rinse, allow the bottles to drain upside down in the dust-free clean room where they are to be used. Clean a 250-mL volumetric flask, a funnel, a punch and the top of the can by the same method used to clean the 475-mL bottles above. In the clean room, shake the can to be tested (clean and hermetically sealed) to distribute uniformly any settled material. Punch the top of the can and transfer a 250-mL sample of oil into each of the cleaned bottles using the volumetric flask and the funnel mentioned above. To one of the samples add 0.50-mL of water conforming to type II of ASTM D1193, using a clean, 1.0-mL graduated pipette. Place the cap on the bottle and shake it thoroughly for 60 seconds. Allow this mixture to stand for 24 hours at a temperature of 24 + 3°C.

4.3.3.6.2 Light transmittance test procedure. At the end of the 24-hour period, place the untreated hydraulic fluid sample in a single beam spectrophotometer capable of being adjusted to 100% light transmittance at approximately 540 nanometers (nm), using a cell with a path length of 1 centimeter (cm). Adjust the light transmittance at 540 nm to 100%. Remove the untreated sample and replace it with the water-treated sample, again using a cell with a 1-cm path length. Record the transmittance reading.

NOTE: The comparison described in 4.3.3.6.2 may be performed in a differential mode, as an alternative.

4.3.3.7 Corrosion protection (humidity cabinet). To determine conformance to 3.3.7, the hydraulic fluid shall be tested IAW ASTM D1748 for 100 ± 1 hours at 49 ± 1°C and 95 to 100% relative humidity, using six test panels. Three of these panels shall be prepared with a polished finish, and three with a sand-blasted finish. Following the test, none of the test panels shall contain more than three corrosion dots, none of which shall exceed 1 mm in diameter.

4.3.3.8 Corrosiveness (bimetallic couple). To determine conformance to 3.3.8, the hydraulic fluid shall be tested IAW method 5322 of FED-STD-791. Following the test, there shall be no evidence of corrosion, etching, pitting or staining in excess of three spots of corrosion on any one disk.

4.3.3.9 Solid particle contamination.

4.3.3.9.1 Particle size. To determine conformance to 3.3.9.1, the solid particle contamination of the hydraulic fluid shall be measured using an automatic particle counter in lieu of the optical procedure detailed in method 3009 of FED-STD-791 (see 6.15). Directions for the operation of the counter to be used shall be followed. The quantity of particles for any size range shall not exceed the numbers specified in table II.

4.3.3.9.2 Gravimetric method. To determine conformance to 3.3.9.2, the solid particle contamination of the hydraulic fluid shall also be measured IAW ASTM D4898 using two 0.45 micrometer (μm) filters. The filtration time shall not be greater than 15 minutes at 25 ±5°C as measured IAW method 3009 of FED-STD-791 with a single 0.45 μm filter. The weight of the filtered contamination shall not be greater than 0.5 mg/100 mL.

4.3.3.10 Foaming characteristics. Subject a sample of the hydraulic fluid to the test procedure IAW ASTM D892, and perform the measurements of 4.3.3.10.1 and 4.3.3.10.2.

4.3.3.10.1 Foaming tendency. To determine conformance to 3.3.10.1, measure the volume of foam after the 5-minute blowing period in each test sequence (see 4.3.3.10). The foam volume shall not exceed 65 mL.

4.3.3.10.2 Foam stability. To determine conformance to 3.3.10.2, measure the volume of foam after the 10-minute settling period in each test sequence (see 4.3.3.10). There shall be no remaining foam, in excess of a ring of bubbles around the edge of the test container.

4.3.3.11 Wear. To determine conformance to 3.3.11, subject a sample of the hydraulic fluid to the test procedure IAW ASTM D4172, and measure the average scar diameters on the steel balls. The average scar diameter on any of the test balls shall not exceed 0.30 mm if the test load was 147 N. If the test load was 392 N, the average scar diameter on any of the balls shall not exceed 0.65 mm. A different 10 ± 0.5 mL sample shall be used for each test.

4.3.3.12 High temperature - high pressure spray ignition. To determine conformance to 3.3.12, the hydraulic fluid shall be tested IAW Method 6052 of FED-STD-791, and shall not continue to burn when the source of ignition is removed.

4.3.3.13 Linear flame propagation. To determine conformance to 3.3.13, the hydraulic fluid shall be tested IAW ASTM D5306, and shall not be more than 0.30 cm/s.

4.3.3.14 Specific gravity. To determine conformance to 3.3.14, the specific gravity of a sample of the hydraulic fluid shall be determined IAW ASTM D287, and shall be compared to the specific gravity of the hydraulic fluid as determined in qualification testing. The specific gravity values shall not vary more than ± 0.008 at 15.56°C/15.56°C.

4.3.4 Interface requirements verifications.

4.3.4.1 Corrosiveness and oxidation stability (metal protection). To determine conformance to 3.4.1, the hydraulic fluid shall be tested IAW method 5308 of FED-STD-791, except that the metal test squares shall be washed at room temperature with aliphatic naphtha, followed by acetone conforming to ASTM D329, instead of 1,1,1-trichloroethane.

4.3.4.1.1 Weight change of test specimens. To determine conformance to 3.4.1.1, after completing the corrosiveness and oxidation stability test (see 4.3.4.1), determine the weight change of the metal specimens IAW method 5308 of FED-STD-791. The weight gain or loss of the metal specimens, except for the copper specimen, shall not exceed 0.2 mg/cm^2. The weight gain or loss of the copper specimen shall not exceed 0.6 mg/cm^2.

4.3.4.1.2 Appearance of test specimens. To determine conformance to 3.4.1.2, after completing the corrosiveness and oxidation stability test (see 4.3.4.1), examine the metal specimens IAW method 5308 of FED-STD-791. There shall be no evidence of etching, pitting, or visible corrosion on the surface of the metal specimens, except for the copper specimen. Any corrosion produced on the surface of the copper specimen shall not be greater than No. 2 of ASTM D130 Copper Corrosion Standards

4.3.4.1.3 Viscosity change. To determine conformance to 3.4.1.3, after completing the corrosiveness and oxidation stability test (see 4.3.4.1), determine the viscosity change of the hydraulic fluid IAW method 5308 of FED-STD-791. The calculated viscosity change shall not exceed ±10%, based on the initial viscosity of the hydraulic fluid.

4.3.4.1.4 Acid or base number change. To determine conformance to 3.4.1.4, after completing the corrosiveness and oxidation stability test (see 4.3.4.1), determine the acid or base

number of the hydraulic fluid IAW method 5308 of FED-STD-791. The acid or base number shall not be more than 0.30 mg KOH/g higher than the initial acid or base number.

4.3.4.1.5 Insoluble material. To determine conformance to 3.4.1.5, after completing the corrosiveness and oxidation stability test (see 4.3.4.1), examine the hydraulic fluid IAW method 5308 of FED-STD-791. The hydraulic fluid shall not show any evidence of insoluble materials or gum.

4.3.4.2 Swelling of synthetic rubber. To determine conformance to 3.4.2, the hydraulic fluid shall be tested IAW method 3603 of FED-STD-791, using standard synthetic rubber NBR-L within 6 months of manufacture (see 6.4). The average percent volume change of the three rubber sheets shall be within the range of 15 to 25%.

4.3.4.3 Compatibility. To determine conformance to 3.4.3, samples of the hydraulic fluid in amounts of 25 mL, 50 mL and 75 mL shall be mixed with samples from each of the fluids previously approved under this specification. Total volume of each mixture shall be 150 mL. Mixtures shall be prepared in 250-mL stoppered flasks. The flasks shall be thoroughly agitated and then stored in an oven at 135°C for 3 hours. At the end of this time, none of the mixtures shall show any signs of sediment, turbidity or crystallization. The sample shall then be stored at –40°C for a period of 3 hours at which time slight turbidity that later disappears will be permitted. Compatibility tests described herein shall also be conducted with a representative fluid qualified to MIL-H-5606, MIL-PRF-6083, MIL-PRF-83282 and MIL-PRF-87257.

4.3.4.4 Color (type II only). To determine conformance to 3.4.4, the hydraulic fluid shall be compared to a test sample prepared by adding one part of “oil red 235” dye (see 6.16) to 10 000 parts of an oil with a color no darker than ASTM Color 1.0 IAW ASTM D1500. There shall be no readily discernible color difference between the hydraulic fluid and test sample.

4.3.5 Support and ownership requirements verifications.

4.3.5.1 Product identification. To determine conformance to 3.5.1, the hydraulic fluid unit containers shall be examined for the proper product warning/identification.

4.3.5.2 Storage stability. To determine conformance to 3.5.2, the hydraulic fluid shall be tested IAW method 3465 of FED-STD-791, and shall be clear and transparent after the test. The aged hydraulic fluid shall be subjected to, and shall pass, all verification tests herein, except solid particle contamination.

4.3.6 Environmental requirements verifications.

4.3.6.1 Flash point. To determine conformance to 3.6.1, the hydraulic fluid shall be tested IAW ASTM D92. The flash point shall not be less than 218°C for type I, and not less than 204°C for type II.

4.3.6.2 Fire point. To determine conformance to 3.6.2, the hydraulic fluid shall be tested IAW ASTM D92. The fire point shall not be less than 246°C.

4.3.6.3 Pour point. To determine conformance to 3.6.3, the hydraulic fluid shall be tested IAW ASTM D97. The pour point shall not be more than –54°C.

4.3.6.4 Evaporation loss. To determine conformance to 3.6.4, the hydraulic fluid shall be tested at 149°C IAW ASTM D972. The mass percent evaporation loss shall be a maximum of 5%.

4.3.6.5 Autoignition temperature. To determine conformance to 3.6.5, the hydraulic fluid shall be tested IAW ASTM E659. The autoignition temperature shall not be less than 343°C.

4.3.6.6 Low temperature stability. To determine conformance to 3.6.6, the hydraulic fluid shall be tested at –40°C IAW method 3458 of FED-STD-791. The hydraulic fluid shall not exhibit any gelling, crystallization, solidification or separation of insoluble material.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The type I hydraulic fluid covered by this specification is intended for use in recoil mechanisms and hydraulic systems of military ground vehicles and equipment. If used in other mechanisms or systems, a study should be made to determine its applicability for such usage, with particular attention given to operation at high and low temperatures and the topic of elastomer compatibility. The hydraulic fluid is rust inhibited and may be used as a preservative medium for hydraulic systems and components. The hydraulic fluid has a wide range of operating temperatures, and is thermally stable, corrosion inhibited and fire resistant. The combination of all of these quantities is not found in commercial hydraulic fluids. This fluid is adopted for military use by NATO countries. The type II hydraulic fluid covered by this specification is intended for use in aerospace test stands, and is essentially identical to type I fluid except that a red dye has been added to assist in detecting small leaks.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number and date of this specification.
b. Type of fluid required (see 1.1).
c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
d. Sample type for particle size contamination (see 4.2.3).
e. If test methods other than as specified (see 4.3).
f. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List (QPL) No. 46170 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the contracting officer.

6.4 Standard elastomer. Samples of the standard synthetic rubber NBR-L for the swelling of synthetic rubber test (see 4.3.4.2) may be obtained from the qualification activity (see 6.3).

6.5 Fluid handling. Owing to the difficulty of preventing contamination after the opening of a container, it is recommended that the hydraulic fluid be purchased in 1-quart and 1-gallon containers by all users. If the fluid is dispensed from larger containers, strict procedures must be employed to exclude and remove moisture, solid particles or other contaminants from the fluid.

6.6 Recommended corrosion inhibitor. It has been found that 1.75 ± 0.25% barium dinony1naphthalene sulfonate provides the required degree of rust protection. The diluent of the rust inhibitor should be the synthetic hydrocarbon base stock.

6.7 Storage conditions. Prior to use of type I in the intended equipment, the product may be stored under conditions of covered or uncovered storage on geographic areas ranging in temperature from –57°C to 71°C.

6.8 Definitions.

6.8.1 Bulk lot. An indefinite quantity of a homogeneous mixture of hydraulic fluid, offered for acceptance in a single, isolated container; or manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.8.2 Packaged lot. An indefinite number of unit containers of identical size and type, offered for acceptance, and filled with a homogeneous mixture of hydraulic fluid from a single, isolated container; or filled with a homogeneous mixture of hydraulic fluid, manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in ingredient materials.

6.9 International standardization. Certain provisions of this specification are the subject of International Standardization agreement NATO STANAG 1135. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including department standardization offices, to change the agreement or make other appropriate accommodations.

6.10 Interchangeability and compatibility. MIL-PRF-46170 fluids are not interchangeable with any other fluids. MIL-PRF-46170 fluids are not to be regarded as compatible with any other fluids except those conforming to MIL-H-5606, MIL-PRF-6083, MIL-PRF-83282 and MIL-PRF-87257. Dilution with MIL-H-5606 or MIL-PRF-6083 severely lowers the flash point.

6.11 Disposal actions.

6.11.1 Background. The product may contain 0.5% tricresyl phosphate, of which not more than 0.01% may be present as the ortho isomer. If this ortho isomer of tricresyl phosphate is absorbed through the skin or taken internally, it may cause paralysis. The corrosion inhibitor contains barium. Accumulated waste liquids will have the exterior of the outer pack marked as containing barium and tricresyl phosphate to assist disposal facilities to manage the product according to regulations promulgated by the US Environmental Protection Agency under Public Law 94-580, Resource Conservation and Recovery Act of 1976.

6.11.2 Handling and safety precautions. Personnel handling the product should wear appropriate impervious clothing to prevent repeated or prolonged skin contact. Local appraisal is required for exact health and safety implications and to prescribe precise application of protective clothing. If skin or clothing becomes moistened with the product, personnel should promptly wash with soap or mild detergent and water. Respirators are not required unless there is an inhalation exposure to mists. Personnel should wear protective clothing when using the product and when cleaning up spills.

6.11.3 Disposal.

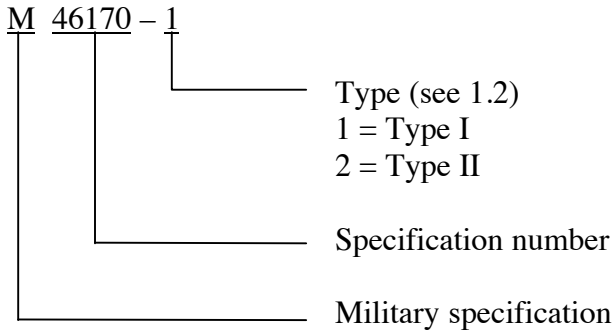
6.11.3.1 Field operations. Depending on the size of spills, paper towels or absorbents will be used to absorb the liquid. Contaminated soil will be removed and placed in a box with absorbents or towels. This box with spill clean-up wastes should either be buried along with ordinary refuse at a rate not to exceed 10 pounds of clean-up wastes per spill event or be incinerated in a permitted municipal waste incinerator. Bulk wastes and contaminated liquids should not be landfilled. Partially full containers of contaminated product should be collected

centrally and stored for later recycle or heat recovery use. State requirements may vary regarding recycle alternatives. Liquids for recycle or heat recovery should be accumulated by repouring in appropriately sized and labeled larger containers (see 6.11.3.3).

6.11.3.2 Depot-type operations. Additionally, used product that has been drained from hydraulic systems will be combined with unused but contaminated fluid from partially full containers and then recycled (see 6.11.3.1).

6.11.3.3 Container disposal. Tops from one-time-use containers should be discarded with ordinary refuse. Containers should be made as empty as possible using draining, after which they should be crushed and buried in a permitted sanitary landfill or incinerated with general refuse. No special decontamination procedures are required for empty containers or their lids.

6.12 Part or identifying number (PIN). The PINs to be used for hydraulic fluid acquired to this specification are created as shown below.



6.13 Subject term (key word) listing.

Acetone
Barium chloride
Barium dinonylnaphthalenesulfonate
Bromine
Cadmium
Chromic acid
Diethylether
Naphtha
NATO STANAG 1135
Petroleum ether
Silver nitrate

6.14 Material Safety Data Sheets (MSDS). Contracting officers will identify those activities requiring copies of completed MSDS prepared IAW FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313; and

29 CFR 1910.1200 requires that the MSDS for each hazardous chemical used in an operation must be readily available to personnel using the material. Contracting officers will identify the activities requiring copies of the MSDS.

6.15 Automatic particle counters. HIAC/Royco counter, model 8011 or equivalent, counting to the limits specified in table II may be used to determine solid particle contamination (see 4.3.3.9.1).

6.16 Dye source. "Oil red 235" dye is manufactured by Passaic Color and Chemical Company, 28-36 Paterson Street, Paterson, NJ 07501 (see 4.3.4.4).

6.17 Changes from previous issue. Marginal notations are not used in this revision to identifying changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - AT
Navy - AS
Air Force – 68

Preparing Activity:
Army - AT

(Project 9150-0176)

Review Activities:
Army – AL, AR, AV, MI, MD
Navy – MC, OS, SA, SH
Air Force - 03
DLA – GS, PS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-46170C	2. DOCUMENT DATE *(YYYYMMDD)* 20010119

3. DOCUMENT TITLE
HYDRAULIC FLUID, RUST INHIBITED, FIRE RESISTANT SYNTHETIC HYDROCARBON BASE

4. NATURE OF CHANGE ***(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)***

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(If applicable)*	7. DATE SUBMITTED *(YYYYMMDD)*

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *(Include Area Code)* (1) Commercial (810) 574-8745 (2) DSN 786-8745
c. ADDRESS *(Include Zip Code)* Commander U.S. Army Tank-automotive and Armaments Command ATTN: AMSTA-TR-E/IE Warren, MI 48397-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888