

MIL-H-5606B

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SUPERSEDING**MIL-H-5606A**

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MILITARY SPECIFICATION**HYDRAULIC FLUID, PETROLEUM BASE;
AIRCRAFT, MISSILE, 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 fluid for use in the -54 to $+71^{\circ}\text{C}$ (-65 to $+160^{\circ}\text{F}$) temperature range in open systems and up to $+135^{\circ}\text{C}$ ($+275^{\circ}\text{F}$) in closed, airless systems. This fluid is identified by NATO symbol H-515.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein:

SPECIFICATIONS**FEDERAL**

TT-T-656 — Tricresyl Phosphate
PPP-C-96 — Cans, Metal, 28 Gage
and Lighter

STANDARDS**FEDERAL**

FED-STD-791 — Lubricants, Liquid
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
Petroleum and Re-
lated Products

(Copies of specifications and standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

**AMERICAN SOCIETY FOR TESTING AND
MATERIALS**

ASTM Standards on Petroleum Prod-
ucts and Lubricants

ASTM Manual on Measurement and
Sampling of Petroleum and Petro-
leum Products

(Application for copies should be addressed to the

FSC 9150

MIL-H-5606B

American Society for Testing and Materials, 1916 Race Street, Philadelphia 3, Pennsylvania.)

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.

3. REQUIREMENTS

3.1 Qualification. The fluid furnished under this specification shall be a product which has been tested and passed the qualification inspection specified herein, and has been listed on or approved for listing on the applicable qualified products list. Any change

in the formulation of an approved product shall require requalification.

3.2 Materials. The fluid shall be clear and transparent consisting of petroleum products with additive materials to improve the viscosity-temperature characteristics, resistance to oxidation, and antiwear properties of the finished product.

3.3 Petroleum base stock requirements. The properties of the petroleum base stock used in compounding the finished fluid, before the addition of any other ingredients required herein, shall be as designated in Table I when tested as specified in 4.7.2.

TABLE I. *Properties of Petroleum Base Stock*

Property	Value
Pour Point (max) ¹	-59.4° C. (-75.0° F.)
Flash Point (min)	98.3° C. (200.0° F.)
Acid or Base No. (max)	0.10
Color, ASTM Std (max)	No. 1

¹ Pour point depressant materials shall not be used.

3.3.1 Specific gravity. The specific gravity of the base stock shall be determined as specified in 4.7.2 but shall not be limited. Samples of base stock submitted for acceptance tests shall not vary by more than ± 0.008 at 15.6/15.6°C (60.0°F) from the specific gravity of the original sample submitted for qualification tests.

3.4 Additive materials.

3.4.1 Viscosity-temperature coefficient improvers. Polymeric materials may be added to the base petroleum oil in quantities not to exceed 20 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. Oxidation inhibitors shall be added to the base oil in quantities not to exceed 2 percent by weight.

3.4.3 Antiwear agent. The hydraulic fluid shall contain 0.5 ± 0.1 percent by weight of tricresyl phosphate, conforming to Specification TT-T-656.

3.5 Finished fluid. The properties of the finished fluid shall be as specified in Table II and 3.5.1 through 3.5.11.

TABLE II. *Properties of Finished Fluid*

Property	Value
Viscosity in centistokes at 54.4° C. (130° F.) (min).	10.0
Viscosity in centistokes at -40° C. (-40° F.) (max).	500
Viscosity in centistokes at -54° C. (-65° F.) (max).	8000
Pour point (max) ¹	-59.4° C. (-75.0° F.)
Flash point (min)	93.3° C. (200.0° F.)
Acid or base No. (max)	0.20

¹ Pour point depressant materials shall not be used.

3.5.1 Color. The fluid 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 fluid and the standard color when tested as set forth in 4.7.3.

3.5.2 Corrosiveness and oxidation stability.

3.5.2.1 Corrosiveness. When tested as specified in 4.7.2, the change in weight of steel, aluminum alloy, magnesium alloy, and cadmium-plated steel subjected to the action of the hydraulic fluid shall be not greater than ± 0.2 milligrams per square centimeter of surface. The change in weight of copper under the same conditions shall be no greater than ± 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. Any corrosion produced on the surface of the copper shall be not greater than No. 3 of the ASTM copper corrosion standards. A slight discoloration of the cadmium shall also be permitted.

3.5.2.2 Resistance to oxidation. When tested as specified in 4.7.2, the fluid shall not have changed more than -5 or +20 percent from the original viscosity in centistokes at 54.4°C (130.0°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 fluid.

3.5.3 Low temperature stability. When tested as specified in 4.7.2 for 72 hours at a temperature of $-54 \pm 1^\circ\text{C}$ ($-65 \pm 2^\circ\text{F}$), the fluid shall show no evidence of gelling, crystallization, solidification, or separation of ingredients. Any turbidity shall be not greater than that shown by the turbidity standard.

3.5.4 Shear stability. When tested as specified in 4.7.4 the percent viscosity decrease of the hydraulic fluid, measured in centistokes at 54.4°C (130.0°F) and at -40°C (-40°F), shall be no greater than the percentage viscosity decrease of the shear stability reference fluid nor shall the acid or base number have increased by more than 0.20 over the original acid or base number.

3.5.5 Swelling of synthetic rubber. When tested as specified in 4.7.2, the volume increase of the standard synthetic rubber L by the fluid shall be within the range of 19.0 to 28.0 percent.

3.5.6 Evaporation. The residue after evaporation for 4 hours at $65.6 \pm 3^\circ\text{C}$ ($150 \pm 5^\circ\text{F}$) shall be oily and neither hard nor tacky when tested as specified in 4.7.2.

3.5.7 Copper strip corrosion. When the fluid is tested as specified in 4.7.6, any cor-

MIL-H-5606B

rosion produced shall be not greater than No. 2 of the ASTM copper corrosion standards.

3.5.8 Solid particle contamination. When tested in accordance with 4.7.2 in a clean dust-free atmosphere, the number of solid contaminant particles per 100 ml of the fluid shall not exceed the number specified in Table III nor shall the weight of the residue exceed 0.3 mg when tested as specified in 4.7.5. The filtering time for each determination shall be 15 minutes maximum.

3.5.9 Foaming characteristics. The foaming characteristics of the hydraulic fluid shall not exceed the limits indicated in Table IV when tested as specified in 4.7.2.

3.5.10 Water. The fluid shall contain less than 100 ppm total water when determined as specified in 4.7.2.

3.5.11 Storage stability. The fully blended product shall show no separation of ingredients nor evidence of crystallization, shall be clear and transparent when examined visually, and shall conform to the requirements of Section 3 (omitting solid particle contamination) within the established tolerance of the qualification sample test results after 12 months storage as specified in 4.7.2.

TABLE III. Solid Contaminant Particles

Particle size range (largest dimension), microns	Allowable number (max) each determination
5-15	2500
16-25	1000
26-50	250
51-100	25
over 100	None ¹

¹ For acceptance testing only, "None" shall be defined as one less than the total number of samples tested.

TABLE IV. Foaming Characteristics of Hydraulic Fluid

Test	Foaming tendency	Foam stability
	Foam volume, ml, at end of 5-minute blowing period	Foam volume, ml, at end of 10-minute settling period
At 75° F.	65 ml (max)	Complete Collapse ¹

¹ A ring of small bubbles around the edge of the graduate shall be considered complete collapse.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless other specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The examination and testing of the hydraulic fluid shall be classified as follows:

- (a) Qualification inspection
- (b) Periodic qualification reevaluation
- (c) Quality conformance inspection

4.3 Sampling. All sampling shall be conducted in a clean-room environment.

4.3.1 Qualification samples. Qualification samples shall consist of 3-1 gallon containers of hydraulic fluid, 1 gallon of the petroleum base stock before the addition of additive agents, 1 gram of the red dye, 8 ounces of the additive used for improving the viscosity-temperature coefficient, 8 ounces of tricresyl phosphate (the antiwear agent), 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 solution shall be furnished. The samples shall be accompanied by a test report from the manufacturer or a commercial laboratory containing complete information as to the source and type of base stock and additive materials used, the formulation and composition of the finished fluid, and laboratory data showing quantitative results of all the tests required by this specification except storage stability. Separate qualification inspection shall be required for each base

MIL-H-5606B

stock used. The samples and reports shall be forwarded to the Supply Department, Building No. 76, Naval Air Engineering Center, Philadelphia 12, Pennsylvania, Attention: Director, Aeronautical Materials Laboratory. The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for qualification inspection
HYDRAULIC FLUID, PETROLEUM
BASE; AIRCRAFT, MISSILE, AND
ORDNANCE
Name of ingredient (for ingredient
material)
Name of manufacturer
Product code number
Date of manufacture

Submitted by (name) (date) for qualification inspection in accordance with the requirements of Specification MIL-H-5606B under authorization of (reference authorizing letter) (see 6.3)

4.3.1.1 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

4.3.2 Periodic qualification reevaluation samples. A periodic qualification reevaluation sample of two 1-gallon hermetically sealed cans of hydraulic fluid shall be selected at random from the first lot of fluid processed under a contract or order after the product has passed qualification inspection. Additional samples may be taken at intervals as considered necessary to verify the consistency of production quality. Peri-

odic qualification reevaluation samples shall be forwarded to the laboratory responsible for qualification (see 6.3). The samples shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for periodic qualification reevaluation
HYDRAULIC FLUID, PETROLEUM
BASE; AIRCRAFT, MISSILE, AND
ORDNANCE
Specification MIL-H-5606B
Name of manufacturer
Product code number
Date of manufacture
Contract or order number
Batch number

4.3.3 Quality conformance inspection samples. The quality conformance inspection samples shall consist of a sample for tests (4.3.3.2), samples for examination of filled containers (4.3.3.3), and samples for determination of solid particle contamination count (4.3.3.4). Samples shall be labeled completely with information identifying the purpose of the sample, name of product, specification number, lot and batch number, date of sampling, and contract number.

4.3.3.1 Lot and batch. All hydraulic fluid manufactured as one batch shall be considered a lot and shall be numbered as such for purposes of inspection. A batch is defined as the end product of all the raw materials mixed or blended in a single operation.

4.3.3.2 Sample for tests. The sample for tests shall be prepared from random samples selected from each lot in accordance with Method 8001 of Standard FED-STD-791 (ASTM D270). This sample shall be subjected to all the applicable Quality conformance tests. If the sample for tests fails any of the Quality conformance tests, the inspection lot shall be rejected. In addition, a random sample of base oil shall be selected for each lot of the finished fluid and shall

MIL-H-5606B

be subjected to all the applicable Quality conformance tests for base oil.

4.3.3.3 Sample for examination of filled containers. A random sample of filled unit containers and a sample of shipping containers fully prepared for delivery shall be selected from each lot of fluid in accordance with Standard MIL-STD-105 at inspection level II and acceptable quality level (AQL) = 2.5 percent defective.

One quart can	100 ml.	1 determination (test)
One gallon can	200 ml.	2 determinations (tests)
Five gallon pail	300 ml.	3 determinations (tests)
Fifty-five gallon drum	600 ml.	6 determinations (tests)

Should the particle count on any individual sample be considered excessive, two additional determinations on another sample from the same container may be used. The container shall be thoroughly shaken immediately prior to withdrawing each 100-ml portion for such additional determinations. The arithmetic average of the two closer particle counts shall be considered the particle count for the sample.

4.4 Qualification inspection. Qualification inspection shall consist of a review for approval of the submitted manufacturer's report and subjecting the qualification samples (4.3.1) to examination and testing for all the requirements of this specification.

4.5 Periodic qualification reevaluation. The periodic qualification reevaluation performed by the qualification laboratory shall consist of examining and testing the periodic qualification reevaluation sample for all the requirements of this specification except storage stability. Delivery of the fluid will not be delayed pending completion of this inspection. If the results of the periodic qualification reevaluation are in accordance with the requirements of this specification, the consistency of production quality shall be thereby verified. Failure of the fluid to pass a periodic qualification reevaluation shall require the acceptance and further shipment

4.3.3.4 Sample for determination of solid particle contamination. Samples of filled and sealed containers shall be taken at such periodic intervals as to be representative of each day's operation. The number of samples taken each day shall be the cube root (to the nearest whole number) of the total number of containers filled that day. The sample size and the number of determinations (tests) per sample for container indicated shall be:

of the fluid to be withheld until the contractor has corrected the conditions which led to the failure (see 6.3.1). Further failure will constitute cause for rejection and removal from the Qualified Products List.

4.6 Quality conformance inspection. Quality conformance inspection shall consist of examination of the sample of filled containers, determination of the solid particle contamination count, and testing the sample for test for all the requirements specified in Section 3 except corrosiveness and oxidation stability, shear stability, solid particle contamination (gravimetric method), swelling of synthetic rubber, and storage stability.

4.7 Inspection methods. Unless otherwise specified, all tests shall be conducted on the hydraulic fluid at a temperature of $25 \pm 2^\circ\text{C}$ ($77 \pm 3^\circ\text{F}$) and at a relative humidity between 45 and 55 percent. Inspection shall be in accordance with Method 9601 of Standard FED-STD-791.

4.7.1 Conformance of the fluid to the requirements for materials (3.2) and additive materials (3.4), shall be determined by appropriate examination and testing in accordance with Section 3.

4.7.2 The following tests shall be made in accordance with the applicable methods

specified in Table V, and 4.7.3 through 4.7.6. Physical and chemical values specified in Section 3 apply to the average of the determinations made on the samples for those values which fall within any stated repeatability or reproducibility limits of the applicable test method.

TABLE V. *Inspection Methods*

Test	FED-STD-791
Pour Point	201
Flash Point	1103
Acid or Base No.	5106
Specific Gravity	401
Color	102
Viscosity	305
Water	3253
Foaming Characteristics	3211
Low Temperature Stability	3459
Swelling of Synthetic Rubber	3603 ¹
Storage Stability	3465
Corrosiveness and Oxidation Stability	5308
Evaporation	353
Solid Particle Contamination	3009 ²

¹ Use standard rubber L (see 6.4) within 6 months after date of manufacture.

² Two 100-ml increments of petroleum ether shall be used to wash the sample.

4.7.3 Color of finished fluid. The color of the hydraulic fluid 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.

4.7.4 Shear stability. The shear stability shall be tested by subjecting the fluid to sonic oscillation.¹ The control fluid and the test fluid shall be run consecutively in the same apparatus and under the same test conditions. The test shall be of 30 minutes duration and the equipment so regulated that the viscosity decrease of the reference fluid (see 6.4) at 54.4°C (130°F) is approximately 15 percent. 30 ml of fluid shall be used in this test.

¹ A 250W, 10KC magnetostrictive oscillator Model DF-101 supplied by the Raytheon Corporation, or its equivalent, may be used. Directions in the manual for respective instruments shall be followed.

4.7.5 Solid particle contamination (gravi-

metric method). The gravimetric procedure for the solid particle contamination determination shall employ apparatus and materials similar to those used in Standard FED-STD-791, Method 3009 or equivalent. As in Method 3009, the apparatus and material shall be carefully cleaned and solvents filtered so that the source of any solid particle contamination must be the test hydraulic fluid itself. This test shall be conducted in a clean, dust-free area with a relative humidity maintained below 50 percent. Two white 47-mm cellulose membrane filters of 0.45 micron porosity shall be rinsed with filtered analytical grade petroleum ether¹, placed, using forceps, in clean, loosely-covered containers, and dried to constant weight in a clean oven at approximately 80°C (176°F). The filters shall be allowed to reach equilibrium with the ambient test area temperature. The filters and their containers shall be placed on an air ionizer to remove any static charge and the filters then weighed to the nearest 0.01 mg to determine their tare weights. The control filter shall be placed below but apart from the sample filter in the filter holder, 100 ± 1 ml of the hydraulic fluid, which has been agitated for approximately 1 minute, shall be filtered using vacuum and washed with 200 ml of filtered petroleum ether¹ from a wash bottle. The last 25 ml of solvent shall be used to wash the test fluid from the periphery of the filter after the upper half of the filter holder has been removed. The solvent flow shall be directed gently towards the center of the filter. The sample filter and the control filter shall again be placed in clean, loosely-covered containers and dried to constant weight in an oven at approximately 80°C (176°F). The filters shall be allowed to come to equilibrium with the ambient test area temperature, the containers with filters placed on an air ionizer, and the filters then weighed to the nearest 0.01 mg. The weight change of the sample filter shall be corrected by the weight change of the control filter. The weight of contaminate shall be expressed in mg per 100 ml of fluid sample. The two filters shall be examined

MIL-H-5606B

under a microscope of approximately 35X magnification. The presence of large or unusual particles shall be cause for discarding and another test shall be made.

¹ Freon TF, manufactured by E. I. DuPont de Nemours and Company, Inc., or equivalent, may be substituted if flammable liquids are unacceptable.

4.7.6 Copper strip corrosion. Prepare 3 copper strips in accordance with Method 5825 of Standard FED-STD-791. The copper strips shall be placed individually in test tubes or other suitable containers so that they will be immersed by 90 ml of the hydraulic fluid. Each fluid container, equipped with an air condenser, shall be immersed in a constant temperature bath capable of maintaining the fluid temperature at $121 \pm 3^{\circ}\text{C}$ ($250 \pm 5^{\circ}\text{F}$). After 72 hours at this test temperature, the strips shall be removed from the fluid, rinsed in sulfur-free acetone, and compared with the ASTM Copper Strip Corrosion Standards.

4.7.7 Examination of filled containers. Each sample of filled container and shipping container shall be examined for defects of construction of the container and closure, evidence of leakage, and net content. 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 inspection 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 fluid shall be in accordance with Standard MIL-STD-290. Unless otherwise specified the fluid shall be furnished in 1-quart and 1-gallon metal cans conforming to Type I of Specification PPP-C-96. All materials used in the con-

struction of the containers shall be such as will not affect or be affected by the contained hydraulic fluid. Just prior to filling, all containers shall be thoroughly cleaned, rinsed with clean filtered fluid, and examined to insure absolute absence of loose solder, dirt, fibers, lint, metal particles, seaming compound, corrosion products, water, or other foreign contaminants. The bottom seam shall show no extruded seaming compound and there shall be no seaming compound on the body immediately adjacent to the side seam. Visible seaming compound, evenly distributed and forming a very fine edge at the point of contact of the seam with the body, shall not be cause for rejection. If a soldered seam is used in the fabrication of the can, residual soldering flux shall not be present on the inside seam of the container.

5.2 Marking. The marking of the hydraulic fluid 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 FLUID IS NOT INTERCHANGEABLE WITH ANY OTHER TYPE OR GRADE OF HYDRAULIC FLUID.

6. NOTES

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

6.1.1 Storage conditions. Prior to use in the intended equipment the product may be stored under conditions of covered or uncovered storage in geographic areas ranging

MLL-H-5606B

in temperatures from -57 to $+49^{\circ}\text{C}$ (-70 to $+120^{\circ}\text{F}$).

6.1.2 This fluid is not interchangeable with any other type or grade of hydraulic fluid.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Type and size of containers (see 5.1).
- (c) Quantity.
- (d) Selection of applicable levels of packaging and packing with requirements in detail.

6.2.1 The fluid covered by this specification should be purchased by volume, the unit being a U. S. gallon of 231 cubic inches at 15.6°C (60°F).

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

6.3 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, 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. The attention of the 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. The activity responsible

for the qualified products list is the Bureau of Naval Weapons, Navy Department, Washington 25, D. C.; however, information pertaining to qualification of products may be obtained from the Director, Aeronautical Materials Laboratory, Naval Air Engineering Center, Philadelphia 12, Pennsylvania.

6.3.1 The fluid furnished under contract shall be identical, within the tolerances of the qualification sample test results established by the qualifying agency, to the qualification samples which have been inspected and approved. In the event that the fluid furnished under contract is found to deviate from the composition of the approved product, or that the product fails to perform satisfactorily, approval of such products will be subject to immediate withdrawal from the Qualified Products List.

6.4 Samples of the standard synthetic rubber L for the test specified in 4.7.2 and 1 pint of the reference fluid for the test specified in 4.7.4 may be obtained from the Director, Aeronautical Materials Laboratory, Naval Air Engineering Center, Philadelphia 12, Pennsylvania.

6.5 The provisions of 1.1 of this specification are the subject of international standardization agreement (ABCAS 15/1 and STANAG 3003). 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.

Custodians:	Preparing activity:
Army—MR	Navy—Weps
Navy—Weps	Project No. 9150-0069
Air Force—AFSC(ASD)	
International interest (see Section 6)	