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MILITARY SPECIFICATION

ADDITIVE, FUEL OIL STABILIZER

This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one type of fuel-soluble additive. When required, it shall be used for stabilizing middle distillate fuels.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standards. The following specification and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

MILITARY
MIL-F-16884 - Fuel, Naval Distillate.

STANDARDS

FEDERAL
FED-STD-313 - Material Safety Data Sheets Preparation and the Submission of.
FED-STD-791 - Lubricants, Liquid Fuels, and Related Products; Methods of Testing.

MILITARY
MIL-STD-290 - Packaging of Petroleum and Related Products.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2.1.2 Other Government document. The following other Government document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issue shall be that in effect on the date of the solicitation.

DEPARTMENT OF LABOR
Code of Federal Regulations, Title 29
Part 1910 - Occupational Safety and Health Standards

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Office, Washington, DC 20402.)

(Copies of specifications, standards and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Tester. (DoD adopted)

D 445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity). (DoD adopted)

D 482 - Standard Test Method for Ash from Petroleum Products. (DoD adopted)

D 613 - Standard Test Method for Ignition Quality of Diesel Fuels by the Cetane Method. (DoD adopted)

D 664 - Standard Test Method for Neutralization Number by Potentiometric Titration. (DoD adopted)

D 974 - Standard Test Method for Neutralization Number by Color-Indicator Titration. (DoD adopted)

D 1298 - Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method. (DoD adopted)

D 2274 - Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method).

D 3828 - Standard Test Methods for Flash Point by Setaflash Closed Tester.

D 4057 - Standard Practice for Manual Sampling of Petroleum and Petroleum Products. (DoD adopted)

D 4625 - Standard Test Method for Distillate Fuel Storage Stability at 43°C (110°F).

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

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(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Fuel oil stabilizer additives furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.4).

3.2 Definition. The stabilizer additive shall represent the additive package proffered by a supplier, whether that additive package is the neat stabilizer additive, the stabilizer additive in a carrier fluid, or a blend of various allowed additives including the stabilizer additive.

3.3 Unblended additive. Unblended additive shall be in accordance with 3.3.1 through 3.3.10.

3.3.1 Material. The material supplied under this specification shall be an additive that, alone or in a package, shall consist of petroleum-soluble compounds. It shall suppress or inhibit the formation of adherent and filterable insolubles in distillate fuel without causing failures in the required properties of the fuel.

3.3.2 Identification. The density at 15 degrees Celsius (°C) (59 degrees Fahrenheit (°F), the viscosity at 0°C (32°F) and 40°C (104°F), the neutralization number, and the pHr shall be determined on the finished stabilizer additive in accordance with 4.6.1.

3.3.3 Recommended effective concentration. Each supplier of stabilizer additive shall specify a recommended effective concentration, not to exceed 25 grams per cubic meter (g/m^3), at which the product shall be used in distillate fuel. The recommended effective concentration shall be expressed both in g/m^3 and in pounds per 100 gallons of fuel.

3.3.4 Toxicity. The material shall have no adverse effect on the health of personnel when it is used for its intended purpose. The fluid shall contain no components that produce noxious vapors in concentrations that annoy personnel during formulation or normal use with adequate ventilation while avoiding prolonged contact with the skin and while observing Occupational Safety and Health Administration (OSHA) guidelines. Questions about toxicity shall be referred by the contracting activity to the Naval Medical Command (NAVMEDCOM), Washington, DC, who will act as a medical advisor to the contracting activity (see 4.7).

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3.3.4.1 Material safety data sheet. The contracting activity shall be provided a material safety data sheet (MSDS) at the time of contract award. The MSDS is form OSHA-20, found in and part of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.5).

3.3.5 Solubility. The additive, or additive package, shall be completely miscible with, and soluble in, the test fuel as defined in 3.4 at three times the recommended effective concentration. There shall be no precipitation, cloudiness, or other evidence of insolubility when tested in accordance with 4.6.2.

3.3.6 Compatibility. The stabilizer additive shall be compatible with stabilizer additives qualified under this specification and with additives contained in distillate fuels. There shall be no precipitation, cloudiness, or other evidence of insolubility, when tested in accordance with 4.6.3.

3.3.7 Metallic substances. The additive or additive package shall not contain metallic substances, either as chemical elements or as compounds, when tested in accordance with 4.6.4.

3.3.8 Ash content. The ash content of the stabilizer additive shall not exceed 0.10 mass percent when tested in accordance with 4.6.5.

3.3.9 Flash point. The flash point of the stabilizer additive shall be not less than 38°C (100°F) when tested in accordance with 4.6.6.

3.3.10 Water separability. The stabilizing additive shall not degrade the water separation characteristics of fuel conforming to MIL-F-16884 fuel when tested in accordance with 4.6.8.

3.4 Test fuels and formulations. Test fuels and formulations shall be in accordance wth 3.4.1 through 3.4.4.

3.4.1 Test fuel. The test fuel to be used in evaluating the stabilizer additive shall meet the requirements specified in MIL-F-16884 except that the storage stability as measured in accordance with ASTM D 2274 shall exceed 2.0 milligrams (mg) per 100 milliliters (mL) and the ignition quality shall be a minimum of 40 as measured in accordance with ASTM D 613.

3.4.2 Reference formulation. The reference formulation shall consist of the test fuel, prefiltered through a 0.8-micrometer membrane filter, with dimethyl cyclohexyl amine added at a concentration of 15 ± 0.15 g/m^3.

3.4.3 Test formulation. The test formulation shall consist of the test fuel, prefiltered through a 0.8-micrometer membrane filter, with the contractor's stabilizer added at the recommended effective concentration (see 3.3.3).

3.4.4 Blend formulation. A blend formulation shall consist of the test fuel, prefiltered through a 0.8-micrometer membrane filter, with the supplier's stabilizer and a stabilizer meeting the requirements of this specification added, each at one-half its recommended effective concentration (see 3.3.3). A blend

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formulation for each stabilizer on QPL-24682 is required for testing compatibility (see 4.6.3) and for ascertaining that the blends do not reduce effectiveness relative to a single stabilizer additive (see 4.6.11).

3.5 Blended additive. Blended additive shall be filterable in accordance with 3.5.1.

3.5.1 Filterability. The filtration ratio of the test formulation (see 3.4.3) shall not exceed 1.0 when tested in accordance with 4.6.9.

3.6 Effectiveness. The additive or additive package shall be effective and free of harmful effects (see 3.3.4). Effectiveness shall be demonstrated in accordance with 3.6.1 and 3.6.2.

3.6.1 Effectiveness by accelerated oxidation stability. The test fuel (see 3.4.1), the reference formulation (see 3.4.2), the test formulation (see 3.4.3), and the blend formulation (see 3.4.4) shall each be tested in accordance with 4.6.10. The values shall be recorded.

3.6.2 Effectiveness by 43°C bottle storage method. The average total insolubles produced in the test formulation samples (see 3.4.3) shall be statistically lower, at the 95 percent confidence level, than the average total insolubles produced by the test fuel samples (see 3.4.1) over the same test period when tested in accordance with 4.6.11. The test formulation shall show a reduction in total insolubles relative to those formed in the test fuel that is not less than 75 percent the reduction produced by the reference formulation.

3.7 Diesel and gas turbine engine operation. The Government reserves the right to require engine tests, to determine the operational acceptability of a stabilizer additive, in diesel engines and in gas turbine engines authorized to operate on diesel fuel. If conducted, such engine tests shall be in accordance with 4.6.12. Engine operation shall not be adversely affected and the condition of the engine after the test shall not indicate any excessive deposits, wear, corrosion, or other deleterious effects attributable to the stabilizer additive.

3.8 Components. The stabilizer additive supplied in accordance with this specification shall consist of a single container per additive package. Two-container packages will not be permitted.

3.9 Workmanship. The finished stabilizer additive in bulk or container shall be uniform in appearance and visually free from grit, undissolved water, insoluble matter, or other adulteration.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves

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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.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA). Qualification inspection shall consist of the tests specified in 4.6.

4.3.1 Qualification sampling. The contractor shall submit a 3-liter sample of finished stabilizer additive for evaluation. Samples shall be identified and packaged, then forwarded to the laboratory responsible for the testing. An additional 3-liter sample of finished stabilizer additive from the same batch shall be forwarded to the laboratory designated to perform testing described in appendix A.

4.4 Quality conformance inspection. Quality conformance inspection of an inspection lot of stabilizer additive shall consist of tests specified in 4.6.1, 4.6.2, 4.6.5 and 4.6.6.

4.4.1 Inspection lot. An inspection lot shall be either a bulk lot or a packaged lot. The following definitions apply to these two terms:

(a) Bulk lot - an indefinite quantity not less than 3785 liters (1000 gallons) of a homogeneous mixture of material offered for acceptance in a single isolated container, manufactured as a single isolated batch, or manufactured by a single plant run not exceeding 5 days through the same processing equipment with no change in ingredient material.
(b) Packaged lot - an indefinite number of 208-liter (55 gallon) drums or smaller unit packages of identical size and type, offered for acceptance, and filled with a homogeneous mixture of material from a bulk lot.

4.4.2 Sampling. Each bulk or packaged lot of material shall be sampled for verification of product quality in accordance with ASTM D 4057.

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4.4.2.1 Drums. When the stabilizer additive is contained in drums, samples shall be drawn in accordance with ASTM D 4057, when the lot consists of less than five drums, one sample shall be drawn from one drum. The contents of each drum to be sampled shall be shaken, rolled and stirred to mix the contents thoroughly. Equal portions shall be withdrawn from the approximate center of each drum to be sampled by a thief or other sampling device.

4.4.2.2 Cans. When the stabilizer additive is contained in cans of 5-gallon or smaller size, five samples shall be drawn in accordance with ASTM D 4057. When the lot consists of less than five containers, each container shall be sampled.

4.5 Inspection. Inspection shall be conducted in accordance with FED-STD-791, method 9601.1.

4.6 Test methods.

4.6.1 Identification. Identification tests shall be conducted in accordance with the following methods:

Density at 15°C (59°F)	- ASTM D 1298
Viscosity at 0°C (32°F) and 40°C (104°F)	- ASTM D 445
Neutralization number	- ASTM D 664
pHr	- Add 0.1 to 0.11 gram of stabilizer additive to 125 mL of titration solvent in accordance with ASTM D 974; standardize apparatus and read pHr in accordance with ASTM D 974, appendix X2.
Metallic constituents	- ASTM D 482

The material requirements shall be in accordance with 3.3.2.

4.6.2 Solubility. One liter of test fuel (see 3.4.1) shall be filtered through an 0.8-micrometer filter into a clean, flat-bottomed, transparent bottle or beaker. An amount of stabilizer additive sufficient to give a concentration level not less than three times the recommended effective concentration (see 3.3.3) shall be added. The mixture shall be stirred or swirled for a period not to exceed 3 minutes to dissolve the stabilizer additive. Check for insoluble materials by swirling the sample so a vortex is formed. Sediment and other insoluble matter will accumulate on the bottom of the bottle or beaker directly below the vortex. If no insoluble matter is noted, the sample shall be covered and checked again after the sample has remained quiescent for 24 hours. The additive shall meet the requirements specified in 3.3.5.

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4.6.3 Compatibility. Blend formulations (see 3.4.4) shall be prepared for each stabilizer additive previously approved under this specification. After the mixture has stood for 24 hours or more, it shall meet the requirements specified in 3.3.6.

4.6.4 Metallic substances. The absence of metallic substances in each lot of stabilizer additive (see 3.3.7) shall be assured by testing by the same technique used in developing identification data (see 4.6.1).

4.6.5 Ash content. The ash content of the stabilizer additive shall be determined in accordance with ASTM D 482. The additive shall meet the requirements specified in 3.3.8.

4.6.6 Flash point. The flash point of the stabilizer additive shall be determined in accordance with ASTM D 93 or in accordance with ASTM D 3828, method B. The additive shall meet the requirements specified in 3.3.9.

4.6.7 Minimum handling temperature. The minimum handling temperature of the stabilizer additive is the temperature below which the additive becomes unsuitable for use because of crystal formation or a viscosity too high for pouring, pumping, mixing, or blending operations normally practiced in the petroleum industry. This temperature shall be determined.

4.6.8 Water separability. The test formulation (see 3.4.3) shall be tested for water separability in accordance with appendix A. The formulation shall meet the requirements of 3.3.10.

4.6.9 Filterability. The test formulation (see 3.4.3) shall be tested for filterability in accordance with appendix B. The filtration ratio shall be as specified in 3.5.1.

4.6.10 Effectiveness by accelerated oxidation stability. The test fuel (see 3.4.1), the reference formulation (see 3.4.2), and the test formulation (see 3.4.3) shall each be tested in quadruplicate in accordance with ASTM D 2274. The qualifying activity may, at its discretion, require tests of 32-hour or 48-hour duration in the 95°C bath in addition to the 16-hour stress period specified in ASTM D 2274. The formulations shall meet the requirements specified in 3.4.1, 3.4.2, and 3.4.3.

4.6.11 Effectiveness by 43°C bottle storage method. The test fuel (see 3.4.1), the reference formulation (see 3.4.2), the test formulation (see 3.4.3), and each blend formulation (see 3.4.4) shall each be tested in quadruplicate in accordance with ASTM D 4625, for an 18-week aging period. The test formulation shall meet the requirements specified in 3.6.2.

4.6.12 Diesel and gas turbine engine operation. The extent of engine testing shall be determined by the activity responsible for qualification. The extent of engine testing shall be based on the chemical composition of the stabilizer additive, and on an evaluation of previous engine test data available from Government or commercial sources. Fuel for engine testing shall conform to either 3.4.1 or to MIL-F-16884 and shall contain the stabilizer additive being

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evaluated at twice its recommended effective concentration. The engine test cycle shall be 100 hours or more and shall conform to an established test method for which baseline data are available on the engine and lubricating oil used in the test. After completion of the test, the engine shall be disassembled and the parts shall be inspected for evidence of excessive wear, deposits, corrosion, or other deleterious effects attributable solely to the stabilizer additive.

4.7 Toxicity. To determine conformance to requirements of 3.3.4, the manufacturer of the material shall disclose the formulation of his product to the Naval Medical Command, NAVMEDCOM-242, Washington, DC 20372. The disclosure of proprietary information, which shall be held in confidence by the Naval Medical Command, shall include: the name, formula, and approximate percentage by weight and volume of each ingredient in the product; the results of any toxicological testing of the product; identification of its pyrolysis products; and any such other information as may be needed to permit an accurate appraisal of any toxicity problem associated with the handling, storage, application, use, disposal, or combustion of the material. Information submitted shall be clearly marked or identified to show it is being provided in connection with qualification under QPL-24682.

4.8 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Packing and marking. The stabilizer additive contained in the size and type container as specified (see 6.2) shall be packed and marked in accordance with MIL-STD-290. The degree of packing shall be as specified (see 6.2).

6. NOTES

6.1 Intended use. The stabilizer additive is intended to be added into distillate fuel to retard the formation of fuel deterioration products such as gums, sludge, and particulates. This product is only for the treatment of fuel at the refinery during the process of manufacture.

6.2 Ordering data. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Size and type of container required (see 5.1).
(c) Degree of packing required (see 5.1).
(d) Quantity. The material should be purchased by volume. The unit of purchase is 1 U.S. gallon (3.785 liters) at 15.6°C (60°F).

6.3 Stabilizer additive for addition to fuels. When a fuel contractor purchases the stabilizer additive for addition to fuels to be used by the Government, the manufacturer of the additive should certify to the purchaser that the product has been qualified under this specification.

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6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL-24682 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. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.5 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in appendix B of FED-STD-313. In order to obtain the MSDS, FAR clause 52.223-3 must be in the contract.

6.6 Subject term (key word) listing.

Additive, blended
Additive, unblended
Oxidation inhibitor
Stabilizer, fuel oil

Preparing activity:
Navy - SH
(Project 6850-N836)

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APPENDIX A

WATER SEPARABILITY EFFECTS OF ADDITIVES ON NAVY DISTILLATE FUEL IN FILTER/SEPARATOR OPERATIONS

10. SCOPE

10.1 Scope. This appendix provides a standard test method for the effects of additives on water separation from distillate fuel by coalescing filter separators.

10.2 Applicability. This method is limited to one type of filter-coalescer and separator element and to one set of test conditions. It does not necessarily indicate results that might be obtained in practice using different types of filter coalescer and separator elements or different operating conditions. This method provides a measure of the tendency of a stability additive to change the effectiveness of a coalescing filter-separator system, and can be used to compare the effects of different additives on the coalescing unit, or to determine whether a particular additive is suitable for use in fuel.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specification. The following specification forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

MILITARY

MIL-F-15618 - Filter-Separators and Filter Elements, Fluid, Pressure, Aviation and Diesel Fuel, Naval Shipboard.

(Copies of specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

20.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B93.22 - Method for Determining the Fabrication Integrity of a Hydraulic Fluid Power Filter Element.

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(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
D 1193 - Standard Specification for Reagent Water. (DoD adopted)
D 1744 - Standard Test Method for Water in Liquid Petroleum Products by Karl Fischer Reagent. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

30. SUMMARY OF METHOD

30.1 Summary of method. One-half percent by volume of distilled water shall be dispersed in a distillate fuel and the mixture passed through a 2.54 centimeter (1-inch) high section of a filter-coalescer and separator element. A second run shall be conducted with 0.5 percent water added to the same fuel containing the recommended effective concentration (see 3.3.3) of the stability additive. A third run shall be conducted with 0.5 percent water added to the same fuel containing three times the recommended effective concentration of stability additive. In all three runs, differential pressures and outlet water concentrations shall be measured over 4 hours at 15-minute intervals. The results of the three runs shall be compared.

40. APPARATUS

40.1 Apparatus. The test apparatus shall be in accordance with the following:

(a) Fuel supply tank - A conical bottom, cylindrical tank that shall hold a minimum of 473 liters (125 gallons) of fuel.
(b) Fuel heater - An external heater that shall raise the fuel supply tank contents from 0°C (32°F) to 21 to 27°C (70 to 80°F) within several hours and shall maintain the control temperature at any selected temperature in that range within plus or minus 1°C (1.8°F) during the test.
(c) Pretreatment filter - A 3-micrometer absolute filter for removing sediment from fuel prior to test.
(d) Water supply tank - A 19-liter (5-gallon) vessel for holding distilled water.
(e) Mixing valve - A 1/4-inch nominal pipe size globe valve.

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(f)	Coalescer assembly	- A filter-coalescer and separator element and housing (see (g)).
(g)	Coalescer element	- A 2.54-centimeter (1-inch) high cross-section segment of a coalescer element provided in accordance with MIL-F-15018.
(h)	Receiving tank	- A vessel with a capacity for receiving the effluent from the coalescer assembly.
(i)	Fuel pump	- A variable-speed pump that shall supply fuel to the system at a rate of 1100 milliliters per minute (mL/min) (0.29 gallons per minute (gal/min)) against a system pressure of no more than 345 kilopascals (kPa) (50 pounds per square inch (lb/in^2)) (a variable-speed Moyno model no. 5BPB655AA1CA, or equal).
(j)	Water pump	- A pump that shall meter distilled water to the system at a rate of up to 22 mL/min against a system pressure of no more than 345 kPa (50 lb/in^2). The pump shall be equipped with a digital unified drive and shall be calibrated to provide the required water injection rate. A peristaltic tube-type variable-speed metering pump has been found satisfactory.
(k)	Test stand	- An assembly of the apparatus specified in (a) through (j), together with associated flow meters, temperature measuring devices, and piping, as shown on figure 1. For proper flow velocities the piping shall be 3/8-inch tubing.
(l)	Karl Fischer assembly	- Karl Fischer apparatus as specified in ASTM D 1744 or, for speed of operation, an automatic Karl Fischer assembly equal to the Aquatest II automatic photovolt apparatus.

50. REAGENTS AND MATERIALS

50.1 Reagents and materials. Reagents and materials shall be in accordance with the following:

(a)	Distilled water	- Water conforming to type II of ASTM D 1193.
(b)	Naval distillate fuel	- Fuel conforming to MIL-F-16884.
(c)	Blended fuel	- The same fuel as in (b) above, but containing the additive to be tested. Either of two additive concentrations shall be specified: the recommended effective concentration or three times that concentration.

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60. PREPARATION OF APPARATUS

60.1 Fuel. A supply of approximately 380 liters (100 gallons) of distillate fuel shall be placed in the fuel supply tank and brought to the operating temperature of 21 to 27°C (70 to 80°F). The fuel shall then be circulated through the pretreatment filter to remove sediment to below 5 milligrams per liter.

60.2 Water. A supply of approximately 8 liters (2 gallons) of distilled water shall be placed in the water supply tank. This water shall be at a temperature of 21 to 27°C (70 to 80°F).

60.3 Filter coalescer and separator elements. Unused filter-coalescer and separator element segments, 1 inch in height, shall be tested for integrity by nondestructive testing in accordance with ANSI B93.22. Only elements passing such nondestructive tests for integrity shall be used.

60.4 Examination for leakage. Coalescer and separator elements passing the test for integrity as specified in 60.3 shall be installed in the housing. The fuel supply pump shall be started and the system shall be filled with fuel. All apparatuses, piping, and connections shall be examined for leakage, and any leaks shall be repaired prior to continuing the test.

70. PROCEDURE

70.1 Flowrate. The fuel flowrate for the distillate fuel to the coalescer-separator assembly shall be set at 1100 mL/min and the pressure drop across the unit shall be recorded. The flowrate of distilled water to the coalescer assembly shall be set at 5.5 mL/min and the pressure drop again recorded.

70.2 Zero-time values. The unit shall run until stabilized. Samples of the fuel shall be taken prior to the injection of water, and as the fuel leaves the coalescer assembly (the outlet fuel). The water content of the two samples shall be determined using the Karl Fischer method in accordance with ASTM D 1744 or an automatic Karl Fischer titrimeter assembly. These values shall be recorded as the zero-time values. The difference between the calculated water content of the inlet fuel (fuel plus water) and the water content of the fuel alone shall be the measure of the free-water content of the inlet fuel. The difference in the water content of the outlet fuel and the water content for the fuel alone shall be the measure of the free-water content of the outlet fuel. These two differences shall be recorded as the zero-time values of free water.

70.3 Free-water content. Every 15 minutes for a period of 4 hours, the pressure drop and the fuel temperature shall be read across the coalescer assembly. Outlet samples shall be analyzed for water content by Karl Fischer. The zero-time water content of the fuel shall be used to calculate the free-water content of the outlet fuel samples. The results shall be recorded.

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70.4 Blended fuel. The distillate fuel shall be replaced with blended fuel of the same distillate fuel but with additive introduced into the fuel a. the recommended effective concentration. Steps 60.1 through 60.4 and steps 70.1 through 70.3 shall be repeated to test the blended fuel.

70.5 Fuel blended at three times the recommended concentration. Steps 60.1 through 60.4 and 70.1 through 70.3 shall be repeated using the same distillate fuel, but with additive introduced into the fuel at three times the recommended effective concentration.

80. CALCULATION AND INTERPRETATION OF RESULTS

80.1 Pressure drop. Pressure drops shall be plotted against the time for the three fuels. If the pressure drop exceeds 103 kPa (15 lb/in^2) at any point, the run shall be repeated. The normal distillate fuel shall give pressure drops below 103 kPa.

80.2 Free water. For all three fuels, the concentration of free water in the effluent fuel shall not exceed 40 parts-per-million (p/m) weight basis. If a plot of the free water versus time shows a single spike exceeding 40 p/m followed by a return to the trend line that is below 40 p/m, the additive shall be considered satisfactory. A repetition of the spike above the 40 p/m level shall be cause for rejection of the additive. The percentage removal of free water shall be calculated using the following equation:

$$\text{Percent removal} = 100 \times (W1 - W2)/W1$$

Where:

W1 = concentration of free water in fuel
W2 = concentration of free water in outlet fuel

The calculation of free water in the inlet fuel shall be calculated from the rates of flow of fuel and water to the coalescer assembly. The measured level of free water determined at zero time shall confirm the calculated free water within 10 percent. A plot of the percentage removal versus time over the course of a test shall show no deviation of over 10 percent from the smooth trend line. Any such major deviation from the smooth trend line shall indicate a major upset in the operation and shall require a repetition of the run.

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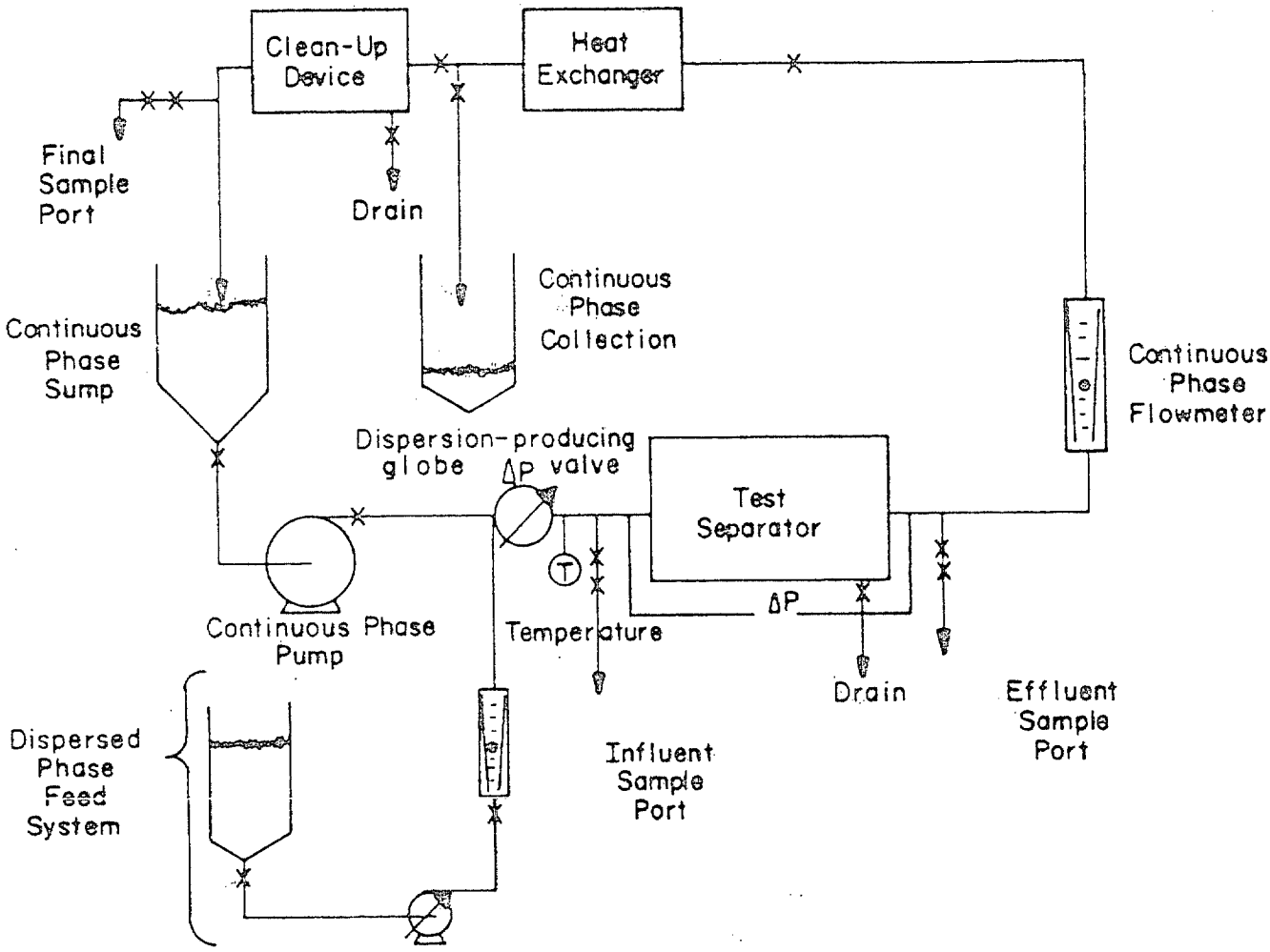

FIGURE 1. Test stand.

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APPENDIX B

DETERMINING THE FILTERABILITY OF DIESEL FUEL

10. SCOPE

10.1 Scope. This method is for determining the filterability characteristics of diesel fuel. It is intended to indicate the potential for the fuel to cause filter plugging problems.

20. SUMMARY OF METHOD

20.1 Summary of method. Five hundred mL samples of test fuel (see 3.4.1) and test formulation fuel (see 3.4.3) are filtered through an 0.8-micrometer filter disc. Fuel filterability is evaluated by the ratio of the filtering time for the test formulation fuel to the filtering time for the test fuel.

30. APPARATUS

30.1 Apparatus. The following equipment shall be used:

(a) 01-092-25 pressure/vacuum pump (Fisher Scientific or equal)
(b) 100-mL filter flask
(c) 500-mL graduated cylinder
(d) Stopwatch
(e) XX10-047-00 pyrex filter folder (Millipore Corporation, or equal)
(f) 0.8-micron filter disc (#AAWP-04700 Millipore Corporation, or equal)

40. PROCEDURE

40.1 Procedure. Filterability shall be tested in accordance with the following procedure:

(a) The fuel samples and glassware shall be stored at 25 ± 1°C (77 ± 1.8°F) until temperature equilibrium is attained.
(b) Five hundred mL of fuel shall be poured into a 500-mL graduated cylinder. The sample temperature shall be maintained at 25 ± 1°C. (It is important to keep filtrations of any one sample at the same temperature. It is also important to keep the filter base clean. The filter base shall be cleaned with petroleum solvents by pouring the solvent into the outlet of the filter base and then forcing it through the base with air. The solvent shall then be sucked from the base before using the filter base to filter fuel.)
(c) An 0.8-micrometer filter disc shall be installed in the holder. The vacuum shall be turned on and allowed to run for 10 to 15 seconds to assure full vacuum. The fuel shall be poured into the filter at such a rate that the fuel filter bowl is full and kept full until all fuel has been poured from the graduated cylinder.

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(d) The disc shall be removed when all the fuel has been pulled through the filter and the filter sucked dry. Five hundred mL of filtrate shall be poured into the graduated cylinder.

(e) A clean 0.8-micrometer disc shall be installed in the filter holder. Five hundred mL of filtered test fuel shall be poured into the filter as in (c) above, except the stopwatch shall be started when the fuel hits the filter disc and stopped when all the fuel has been pulled through. The sample shall be maintained within plus or minus 1°C (plus or minus 1.8°F) of the test temperature during this step.

(f) The sample shall be maintained within plus or minus 1°C of the test temperature for 4 hours prior to completing this step. With the filter disc in place, the fuel shall be poured out into the flask. The 500 mL of test formulation fuel shall be filtered and timed through the same filter disc that was used in step (e).

50. CALCULATION

50.1 Calculation. To calculate the filterability of the fuels, the time obtained in 40.1(f) shall be divided by the time obtained in 40.1(e), and the quotient rounded to the nearest 0.1. If the result is 1.0, the fuel is perfectly filterable. Values greater than 1.0 indicate a potential problem due to incompatibilities between the fuel and additives. Higher ratio values indicate greater filterability problems.

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