

MIL-O-19838 (Aer)
12 December 1956

MILITARY SPECIFICATION
OIL SYSTEMS: AIRCRAFT, INSTALLATION
AND TEST OF

This specification has been approved by the
Bureau of Aeronautics, Department of the Navy

1. SCOPE

1.1 Scope: This specification covers the general requirements for design, functional operation, installation, and testing of oil systems for piloted aircraft, target drones and guided missiles, and shall be followed except as otherwise authorized by the Bureau of Aeronautics for each design.

1.2 Classification: This is a performance specification.

2. APPLICABLE, DOCUMENTS

2.1 The following specifications, publications, and drawings of the issue in effect on the date of invitation for bids, form a part of this specification.

SPECIFICATIONS:

MILITARY

MIL-T-5579	Tanks; Self-Sealing Oil, Aircraft
MIL-H-5593	Hose; Aircraft, Low-Pressure, Flexible
MIL-C-5637(ASG)	Coolers, Lubricating Oil, Aircraft, Tubular
MIL-V-5636	Valves; Oil Cooler (Temperature Regulating with Surge Protection)
MIL-T-6396(ASG)	Tanks, Fuel, Oil, Water-Alcohol, Coolant Fluid Aircraft, Non-Self-Sealing, removable
MIL-C-8678(AER)	Cooling Requirements of Power Plant Installations
MIL-D-8706(AER)	Data, Design; Contract Requirements for Aircraft
MIL-F-17874(AER)	Fuel Systems; Aircraft, Installation and Test of
MIL-S-7742	Screw Threads, Standard, Aeronautical
MIL-I-18802(AER)	Installation of Fuel and Oil Lines and Connections in Naval Aircraft
MIL-W-25140(ASG)	Weight and Balance Control Data (for airplanes and Rotorcraft)
MIL-C-7244(ASG)	Cap and Adapter Unit, Tank Filler
MIL-F-5577	Fittings; Self-Sealing and Bladder Type Tank, Aircraft

DRAWINGS

AN4103	Valve-Oil Cooler Temperature Regulating with Surge Protection
AN4124	Cooler-Lubricating Oil, Aircraft Tubular, Elliptical
AN4125	Cooler-Lubricating Oil, Aircraft Tubular, Round
MS28034	Bulbs, Temperature, Electrical Resistance (-70°C to +300°C)
AND10056	Fitting End, Standard Dimensions for Flared Tube Connection and Gasket Seal

PUBLICATIONS

Air Force-Navy Aeronautical Bulletins

AN4143	Specifications and Standards, use of
AN4186	Valve, Oil Dilution and Separately Mounted Priming Solenoid

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Bureau of Aeronautics

Technical Order No. 37-54 Application and Instructions for use of Aircraft and Engine Lubricating Oil. (use 1957 replacement T.O. if avail.)

(When requesting specifications, publications and drawings refer to both title and number. Copies of this specification and applicable specifications may be obtained upon application to the Commanding Officer, Naval Aviation Supply Depot, Philadelphia 11, Pennsylvania, Attention: Code ODPT)

2.2 OTHER PUBLICATIONS: The following documents form a part of this specification unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

National Advisory Committee for Aeronautics Report T.N. 3182 - Manual of the International Civil Aviation Organization (ICAO) Standard Atmosphere.

(Copies of this publication may be obtained from the Research Information Division, National Advisory Committee for Aeronautics, 1512 H. Street N.W., Washington, D. C.).

3. REQUIREMENTS

3.1 COMPONENTS: The approval and installation of components under the requirements of this specification applies to functional components as distinguished from such other components as lines, fittings, tanks and associated components. Functional components will generally include the following: Valves, filters, filler units, filler caps, oil coolers, pressure regulators, and oil tank pressure control units.

3.1.1 COMPONENTS APPROVAL: All functional components employed in the oil system shall be of approved types and shall have passed the qualification tests required in the applicable specifications. A list of all functional components shall be submitted to the Bureau of Aeronautics, under the requirements of this specification and specification MIL-D-8706(AER), for review and approval prior to procurement of these components by the contractor. Components listed for approval shall include sufficient identifying data, including the following as applicable.

- a. Name of Component
- b. Vendors P/N and/or drawing number
- c. Applicable Government Specifications and Drawings (and deviations, if any)
- d. Present Qualification or Approval Status
- e. Aircraft Manufacturer's Drawings and P/N
- f. Aircraft Manufacturer's Procurement Specification

3.1.1.1 STANDARD COMPONENTS: Components in this category are those which are covered by applicable Qualified Products List, Government Specifications, and drawings. Those components which are listed on an applicable Qualified Products List or other Government Approved lists will be approved. Those components currently undergoing Government qualification tests may be approved subject to satisfactory completion of the tests. In the case of components which are qualified or are undergoing qualification but which are being applied to special installations not adequately covered by applicable specifications, approval may be granted subject to satisfactory service and subject to completion of special qualification tests pertinent to the particular installation. In the case of those components which are not listed on an applicable Government Approval list and which have not been submitted for Government qualifications tests, the submission of samples for such tests will normally be required; approval in this instance may be granted subject to satisfactory completion of such qualification tests.

3.1.1.2 NON-STANDARD COMPONENTS: Components in this category will be considered those which do not apply under a specific Government specification or drawing but which are commercially available. Approval may be granted on the basis of prior satisfactory service experience and subject to satisfactory service in the particular application.

3.1.1.3 NEW DEVELOPMENT COMPONENTS: Components in this category will be considered those which must be designed and developed for the specific airplane application. Those components will require the submission by the aircraft manufacturer of detailed procurement specifications and envelope drawings for release in accordance with ANA Bulletin 143.

3.1.2 COMPONENTS INSTALLATION: All components shall be designed to permit ease of installation and removal. Components requiring frequent servicing shall be installed under quick opening access doors in the airplane skin and shall be easily accessible.

3.2 MATERIALS: All materials shall be fully suitable for the purpose intended.

3.3 DESCRIPTION: The lubricating system includes tanks, measuring devices, coolers, pumps not integral with the engine, piping exterior to the engine, strainers, fittings, valve, etc. A separate oil tank and necessary accessories shall be provided for each engine not having a self-contained oil system. Lubrication system components shall be approved by the Bureau of Aeronautics and be compatible with all oil requirements as specified by the Navy in T.O. 37-54. The lubrication system shall not limit the engine's altitude performance and shall maintain sufficient oil pressure to insure satisfactory engine operation for a period of not less than 30 seconds during negative "G" flight conditions.

3.3.1 ARRANGEMENT: The lubricating system shall be so arranged that, with the engine running at any speed from idling to full power, the delivery of oil to the engine inlet to provide the required engine lubricating system pressure will be automatically maintained for normal flight and over the range of extreme flight attitudes encountered during the fulfillment of mission as specified in the applicable airplane detail specification down to the zero usable oil capacity level.

3.4 OIL TANKS: Bladder type or metal oil tanks, including corrosion-resistant steel tanks, shall be in accordance with Specification MIL-T-6396(ASG). Self-sealing oil tanks shall be in accordance with Specification MIL-T-5579.

3.4.1 OIL TANK CAPACITY: The usable capacity of oil tanks (excluding expansion and foaming space) shall be as follows:

(1) Reciprocating Engines - One twenty-fifth (by volume) of normal mission fuel load or one thirtieth (by volume) of maximum ferry or overload fuel whichever is greater. (For possible modification of capacities see paragraph 3.17)

(2) Turbo-Engines - The engines oil consumption unit rate specified in the engine specification, times the maximum airplane endurance, times a factor of one and one-half. For airplanes for which flight refueling is specified, the usable oil capacity shall be increased by an appropriate quantity as required by the detail specification. "Unusable Oil" is defined as the total oil that is unavailable to the engine and other auxiliaries serviced by the engine oil tanks under the conditions specified in paragraph 3.3.1 and includes "trapped oil" as defined by specification MIL-W-25140(ASG).

3.4.2 PROPELLER FEATHERING OIL (MULTIENGINE AIRPLANES): In multiengine airplanes equipped with hydraulically feathered propellers employing oil from the lubricating system, a separate 1 gallon supply of oil for each propeller shall be provided for use only by the propeller feathering pumps. This oil supply shall normally be contained in a compartment in the engine oil tank above the sump oil level such that oil is always available for feathering. The supply shall be automatically replenished whenever the oil level in the engine oil tank is more than 50 percent of the minimum

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usable oil capacity required by the detail specification.

3.4.2.1 PROPELLER FEATHERING LINES: Propeller fluid lines shall be approved flexible assemblies capable of enduring a 2000°F flame for five minutes without leakage. Protective sleeves shall be provided to fire proof the lines. Installation of these lines shall be in accordance with MIL-I-18802(AER).

3.4.3 EXPANSION AND FOAMING SPACE

3.4.3.1 OIL TANKS (RECIPROCATING ENGINES): Expansion and foaming space shall be provided in service oil tanks in a volume equal to 20 percent of total oil tank capacity plus 20 percent circulating oil with circulating oil defined as the quantity of oil which circulates during engine oil dilution. (For possible modification of foaming space see paragraph 3.17).

3.4.3.2 OIL TANKS (TURBO-ENGINE)

3.4.3.2.1 TURBO-JET ENGINES: Expansion and foaming space shall be provided in the service oil tanks in a volume equal to 20 percent total oil but not less than 1 qt.

3.4.3.2.2 TURBO-PROP ENGINES: Expansion and foaming space shall be provided in the service oil tanks in a volume equal to 60 percent total oil.

3.4.3.3 AUXILIARY OIL TANKS: Auxiliary oil tanks shall provide for thermal expansion space equal to 3 percent of capacity.

3.4.4 OIL TANK FILLER UNITS: Oil tank filler units shall have a nominal diameter of 3", unless otherwise approved by the Bureau of Aeronautics, and shall be designed in accordance with MIL-C-7244(ASG). Remote filling provisions shall be in accordance with 3.4.4.4 below.

3.4.4.1 TANK FILLER CAP SECURITY: Filler caps installed under access doors shall be so arranged that the access door cannot be completely closed if the cap is not in place, or in place but not secured.

3.4.4.2 FILLER UNIT SCREEN (RECIPROCATING ENGINES): A large capacity oil screen of number 10 mesh or equivalent shall be provided in the oil tank for screening only the service oil. The screen shall have sufficient capacity to permit servicing the oil tank in 2 minutes, except that the rate need not exceed 20 gallons per minute, using the oil specified for normal use with the engine servicing oil temperature of 150°C (590°F).

3.4.4.3 FILLER UNIT SCREEN (TURBO-ENGINE): Shall be provided. Approval by BuAer of the specific item is required.

3.4.4.4 REMOTE FILLING PROVISIONS: Remote filling shall be provided as needed and shall be as approved by BuAer. The service and the overflow lines shall be of different diameter and shall be designed such that mismatching of these lines with other aircraft lines cannot occur.

3.4.5 OIL TANK INSTALLATION: When a separate oil tank is required, it shall be located as near the oil pump as possible, but shall not be located in any compartment where it is subjected to high temperatures (see MIL-C-8678 for temperature requirements) and shall conform with the requirements of either MIL-T-5579 or MIL-T-6396(ASG). The bottom of the oil tank shall be as high above the level of the oil pump as practicable. If the engine oil pump is above the mean normal capacity level of the tank with the airplane in its normal static position, an oil booster pump or other suitable means (subject to BuAer approval) shall provide a positive head of oil to the engine-driven pump. In multi-engine airplanes, one service oil tank shall be provided for each engine. Separate oil tanks in multi-engine airplanes shall be interchangeable. Oil tanks shall be supported in fireproof cradles or other fireproof means for distributing the weight throughout the entire tank structure. Oil tanks, except integral structures, shall be so installed that they may be removed or replaced with minimum disassembly of

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the airplane structure. Where practicable, the oil system shall be an integral part of the quick-engine-change unit. Aluminum, bladder, or self-sealing tank construction shall be protected as necessary to provide fire resistance equivalent to 0.012 inch corrosion-resistant steel construction.

3.5 PIPING AND FITTINGS: Piping and fittings, and their installation shall be in accordance with Specification MIL-I-18802(AER). The size of piping and fittings for oil suction and return line shall be determined by the requirements under ARRANGEMENT in paragraph 3.3.1 but shall not be less than 1 inch outside diameter by 0.049-inch wall, or equivalent. Materials shall be aluminum.

3.5.1 STANDARD PARTS: Standard parts (MS or AN) shall be used wherever they are suitable for the purpose, and shall be identified on the drawing by their part number. Non-standard parts may be used where the standard parts will not fulfill the design objectives because of size, weight or performance. The use of non-standard parts shall be discouraged and shall be subject to approval by the Bureau of Aeronautics Representative.

3.5.2 THREADS: Only straight threads conforming to specification MIL-S-7742, National Fine Thread Series, class 3 (NF3) or Unified Thread Series, classes 3A or 3B shall be used.

3.6 TEMPERATURE AND SURGE CONTROL: Provisions shall be made, unless incorporated in the engine, for maintaining an inlet oil temperature not exceeding that specified in the engine specification under the conditions in Specification MIL-C-8678(AER) and in accordance with Navy T.O. 37-54.

3.6.1 OIL COOLERS: Oil coolers for reciprocating-engine airplanes, other than Training-class airplanes shall be in accordance with Drawing AN4124 or AN4125 meeting the requirements of Specification MIL-C-5637A(ASG). Oil coolers for Training-class airplanes and for turbo-engine airplanes shall conform with the requirements of Specification MIL-C-5637A(ASG) as applicable to the range of performance of the particular airplane. Elliptical and round oil coolers shall be in accordance with Drawing AN4124 and AN4125, respectively, while coolers of other shapes shall be subject to specific approval of BuAer.

3.6.2 TEMPERATURE REGULATION: Temperature regulating valves for Drawing AN4124 and AN4125 cooler installations shall be in accordance with Drawing AN4103 meeting requirements of Specification MIL-V-5636A. Temperature regulating valves for other types of oil coolers shall be subject to specific approval by BuAer. All temperature regulating valves used in reciprocating engine installations shall be compatible with and readily converted for satisfactory use of either grade 1100 or grade 1065 oils.

3.6.3 TEMPERATURE INDICATION: A thermometer bulb, Drawing MS-28034 shall be installed in the well provided in the engine to indicate the temperature of the oil entering the engine.

3.7 GENERAL REQUIREMENTS FOR OIL DILUTION (RECIPROCATING ENGINES):

3.7.1 Installation - Oil dilution systems shall be installed to withstand the severe usage and vibration encountered in aircraft under service conditions.

3.7.2 Percentage Dilution Desired - The desired percentage of oil dilution is 15 percent by volume in the engine sump with a minimum (not more than 3% to 5%) in the main portion of the oil tank outside the warm-up compartment. Although only 15% is desired, the system shall be so designed that with 25% dilution, oil will not be discharged out the engine breather during operation at take-off power following a normal warm-up.

3.7.3 Operating Time - Approximately 15% dilution by volume shall be obtained in not more than nine minutes. However, a dilution period of from three to six minutes is preferred.

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3.7.4 Component Parts - Each oil dilution system shall include a suitable restrictor fitting, a solenoid dilution valve, a manual shut-off valve, an oil diverter valve, and the necessary wiring, switch and lines.

3.7.5 Separate Systems - In multi-engine aircraft there shall be an independent oil dilution system for each engine.

3.7.6 Arrangement - The oil dilution system shall conform essentially to one of the typical arrangements shown on Figures 1 and 2.

3.7.7 Location - The oil dilution system shall be installed in any convenient location, preferably forward of the firewall, which provides the shortest practicable coupling of components. No part of the oil dilution system shall be mounted on the engine or attached to parts which vibrate with the engine.

3.7.8 Tubing - Unless otherwise specified, the fuel lines for oil dilution shall be one-fourth inch outside diameter approved aluminum alloy solid wall tubing with .042 inch wall thickness or one-fourth inch diameter hose in accordance with specification MIL-H-5593A. All oil dilution lines shall be installed in accordance with the applicable sections of Navy Aeronautical Specification MIL-F-17874(AER) and MIL-I-18802(AER).

3.7.9 Diluent

3.7.9.1 Fuel for oil dilution shall be obtained at any convenient point in the fuel system downstream of the auxiliary fuel pump or booster pump subject to the requirements of paragraph 3.7.7 above.

3.7.9.2 The diluent shall be added to the lubricating oil system in the engine oil inlet line between the oil tank and the engine. The point where the diluent is added shall be located as far from the engine oil pressure pump as practicable in order to insure thorough mixing of the diluent and oil prior to entering the engine.

3.7.10 Restrictor Fitting - Except where otherwise specified, a suitable fitting with a #43 (0.0890") restriction shall be located in the dilution line at the point where the diluent is obtained.

3.7.11 Dilution Solenoid Valve - Unless otherwise specified, an ANA Bulletin No. 186d oil dilution solenoid valve shall be used. This solenoid valve shall be installed as close as practicable to the restrictor fitting.

3.7.12 Manual Shut-Off Valve.

3.7.12.1 A manual shut-off valve of approved type shall be mounted in the oil dilution lines at the point where the diluent is added to the oil. The purpose of this shut-off valve is to isolate the dilution line and obviate the following hazards:

1. Loss of oil pressure due to failure or puncture of the line between the dilution solenoid and the oil inlet line, with consequent loss of engine oil pump suction.

2. Excessive dilution resulting from possible leakage through the dilution solenoid.

3.7.12.2 The manual shut-off valve shall be so located as to be convenient for operation before and after dilution. The locations of the dilution solenoid valve and the manual shut-off valve may be exchanged if this exchange will make the shut-off valve more convenient for operation. However, the solenoid and manual valves shall be at opposite extremities of the dilution line.

3.7.13 Oil Diverter Valve - An oil diverter valve or the equivalent thereof shall be included to divert the flow of oil into the warm-up compartment of the oil tank during dilution regardless of the oil temperature. The type, location, and arrangement

of this diverter valve shall be subject to approval by the Bureau of Aeronautics. Typical locations for the diverter valve are shown on Figures 1 and 2.

3.7.14 Control Switches.

3.7.14.1 A momentary contact toggle switch of approved type shall be provided for operating the oil dilution system. In single engine aircraft the oil dilution switch shall be located adjacent to the primer switch. In multi-engine aircraft the oil dilution switch shall be conveniently located in the general vicinity of the starter and primer switches.

3.7.14.2 The oil dilution switch shall simultaneously operate the solenoid dilution valve, the oil diverter valve (if solenoid operated), and the auxiliary fuel pump. This switch does not replace the switch required for normal operation of the auxiliary fuel pump.

3.8 The identical oil dilution system to be used in production aircraft shall be installed in an experimental airplane and tested in accordance with applicable subparagraphs of paragraph 4 below.

3.9 WARM-UP PROVISION (RECIPROCATING ENGINES): Warm-up provisions in the form of compartments and diverter valve installations are required if the circulation time based on normal mission oil capacity divided by normal rated power engine-oil-flow-rate, as specified in the engine specification, exceeds 1 minute for carrier-based airplanes and 2 minutes for land-based airplanes. If a warm-up compartment is required by the above, the capacity shall be approximately equal to one-tenth of engine-oil-flow-rate at normal rated power, as specified in the engine specification, plus 2 gallons. Warm-up compartments and diverter valve provisions may be incorporated in smaller tanks to minimize oil dilution expansion space requirements under the provisions of paragraph 3.4.3.1.

3.10 WARM-UP PROVISIONS (TURBO-PROP ENGINES): Warm-up provisions for turbo-prop engines shall be as required by the detail specification.

3.11 SHUT-OFF VALVE AND CONTROL (MULTI-ENGINE AIRPLANES): Oil shut-off valves shall be provided for each engine of all multi-engine airplanes. Provision shall be made in multi-engine airplanes for shutting-off or otherwise preventing hazardous quantities of fuel, oil, anti-icing and other flammable fluids from flowing into, within, or through any power plant or electronic compartment, or other combustion equipment compartment, except that means need not be provided to shut-off flow in lines forming an integral part of an engine. The shut-off shall be operable from the cockpit and shall be located outside the above compartments, unless an equally high degree of protection is otherwise provided. No hazardous quantity of flammable fluid shall drain into any of the above compartments after shutting-off has been accomplished.

3.12 DRAINAGE PROVISIONS: A main drain valve at the lowest point in the engine oil-in-line and a tank sump drain shall be provided to obtain complete drainage of the oil tank. The drain valve for tank sump shall be one-half inch with Drawing AND10056-8 outlet port. The main drain valve shall be of the same size as the engine oil-in-line with Drawing AND10056 outlet port except that the valve need not exceed a size $1\frac{1}{2}$ inches. Drain valves shall be self-locking.

3.13 OIL COOLER DRAINAGE: The oil cooler drain plug shall be accessible for drainage and oil shall drain clear of the airplane. Complete oil cooler drainage is not required, however, oil coolers shall be drained to a "wet" weight not exceeding 50 pounds to facilitate removal.

3.14 ENGINE OIL DRAIN: Engine oil drain plugs shall be readily accessible. The airframe contractor shall insure that the drain fluid discharges clear of the airplane.

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3.15 DEAERATION PROVISIONS: The expansion and foaming space requirements of paragraph 3.4.3.1 are representative of reasonable tank design and lubricating system characteristics. Deaeration provisions may be incorporated with a reduction of the foam space requirements of paragraph 3.4.3.1. Additional deaeration provisions and/or increase in foam space shall be provided as necessary to prevent excessive tank pressures or overboard discharge of oil due to the engine foaming characteristics or compromise of tank design characteristics.

3.16 VENT AND BREATHER SYSTEM: Main oil tanks shall be vented to the appropriate engine connection. Liquid pockets shall not form in the oil tank vent lines. If no vent connection is furnished on the engine, the oil tanks shall be vented overboard and designed to prevent discharge of solid oil from the vent outlet. The inlet to the vent line shall be uncovered within the angular limits of climb and dive specified for the fuel system of the airplane. When a breather connection is provided on the engine, breather pipes shall be designed to conduct oil vapors from the engine breather to the open air clear of the exhaust outlets, the pilot's windshield and bomber's window. This discharge line shall be located on the under side of the engine accessory compartment, not immediately forward of bombs or other external projections, so that approximately ambient air pressure is imposed on the outlet. Particular attention shall be given to the prevention of vent and breather icing at low temperature. Vent and breather lines which pass through unheated areas shall be lagged or provided with means of heating to prevent ice accumulation within the lines. Where oil dilution is used there shall be no breather discharge for dilutions up to and including 25 percent.

3.17 OIL TRANSFER SYSTEM (RECIPROCATING MULTI-ENGINE AIRPLANES): When an oil transfer system is used in reciprocating multi-engine airplanes for transferring make-up oil from a control location to service oil tanks of each engine, the total capacity of usable oil may be reduced to one thirty-fifth (by volume) of maximum ferry or overload fuel capacity except that the usable oil capacity of the engine service tanks shall be not less than one twenty-fifth (by volume) of normal mission fuel load. When make-up oil is carried in stored containers, an auxiliary make-up oil tank is not required. The oil transfer system shall be capable of satisfactory operation at flight ambient air temperatures of -65°F.

3.18 OIL QUANTITY GAGING: Multi-engine Patrol, Utility, and Transport class airplanes shall be equipped with an oil quantity gaging system of approved type for indicating oil capacity at the pilot's or flight engineer's station unless otherwise approved by BuAer. Airplanes equipped with oil transfer systems shall be provided with an oil quantity gaging system or a low or full level transfer indicating system with the low level indications set at approximately 20 percent of service tank usable oil capacity. All oil tanks shall be provided with dip sticks. Dip sticks and quantity gaging systems shall be calibrated. The service oil tank zero-oil-level shall be indicated at zero-usable-oil.

3.19 OIL PRESSURE GAGING: Provisions shall be made for indicating the oil pressure in the lubricating system on the discharge side of the pressure pump at the location designated by the engine manufacturer.

3.20 SCAVENGE OIL STRAINER (RECIPROCATING ENGINES ONLY): Scavenge oil strainer shall be provided and shall be a type approved by BuAer.

4. QUALITY ASSURANCE PROVISIONS

4.1 SAMPLING: Not applicable.

4.2 INSPECTION: Not applicable.

4.3 TESTS: The following tests shall be conducted and a report thereon shall be submitted. "Tests" under this specification include computation and analysis as well as physical tests as noted. The report shall include, for information and reference purposes, a complete schematic arrangement of the aircraft oil system together with a

listing by manufacturer and part number of all functional components as defined in paragraph 3.1. Where tests are reported separately, they shall be submitted as addenda or amendments to the basic oil system report rather than by separate report title. Tests listed in this specification which are not applicable to an airplane shall be listed by title with appropriate notation rather than omitted from reference in the oil system test report.

4.4 EQUIPMENT: Not applicable.

4.5 PROCEDURE

4.5.1 The oil system tests as specified herein shall be conducted by the contractor to demonstrate satisfactory lubrication and oil system installation on pre-production aircraft. A report shall be submitted in accordance with the requirements of MIL-D-8706(AER).

4.5.2 Test Conditions - The tests shall be performed as described herein.

4.5.3 Where power plant installation test methods other than these described herein must be used, they shall be briefly described and data submitted to facilitate comparisons with the standard procedure.

4.5.4 Calibration of Instruments - All instruments shall be calibrated immediately prior to the power plant installation tests and at frequent intervals during the tests.

4.6 ENGINE OIL SYSTEM TEST: The purpose of this test is to determine if the engine oil system operates satisfactorily, maintains necessary oil pressure, and is free from excessive oil discharge from the breathers.

4.6.1 Test Requirement - Normal engine oil inlet temperature, as specified by the engine model specification, shall be maintained by the temperature controls.

4.6.2 Instrumentation - The instrumentation to record the data as follows:

- (1) Temperature, Cylinder Head, spark plug gasket or inbedded type (cockpit instrument) (reciprocating engines only).
- (2) Temperature Oil in.
- (3) Temperature Oil out.
- (4) Temperature Free Air.
- (5) Air Speed.
- (6) Pressure Altitude.
- (7) Manifold Pressure (reciprocating engines only).
- (8) Engine Oil Pump Pressure (inlet and outlet).
- (9) RPM.
- (10) Blower Setting (reciprocating engines only).
- (11) Torquemeter Reading (reciprocating and turbo-prop installations) where applicable.
- (12) Time (clock time).
- (13) Oil Cooler Inlet Pressure.
- (14) Mixture Setting (reciprocating engines only).
- (15) Scavenge Pump discharge pressure.
- (16) Tailpipe Temperature (turbine engines only).
- (17) Tailpipe area (turbine engines only).

4.6.3 Procedure - The tests shall be as follows:

(a) With a one-fourth filled tank, flight tests shall be made at the flight attitudes, including slip, climb and dive attitudes, required in the applicable airplane detail specification. The flight test shall be made at any desired altitude.

(b) The dive tests shall be made at normal rated engine RPM and Power and from any desired altitude, to maximum allowable airplane velocity and shall be preceded by a

push-over made at the maximum allowable negative acceleration specified in the applicable design specification.

(c) The normal rated power climb test shall be started immediately after take-off and terminated at service ceiling.

(d) With a one-fourth filled tank, airplanes which may be inverted in flight shall be flown inverted for ten seconds. Rated engine RPM and power shall be maintained.

4.6.4 Data - Prior to and immediately after each test, all readings, as listed in paragraph 4.6.2 shall be taken. During each maneuver the oil pressure shall be observed and any deviation from normal recorded. In addition to including the above data in the Lubrication System Report, tests number 1, 3, and 4 of Table II, and items 1 and 2 of Table I, shall also be plotted against altitude and included in this report. Also, for test number 2 of table II, the oil pressure and altitude shall be noted in this report. The breather discharge condition shall be noted during the above flight tests and any breather discharge shall be noted, along with the flight test conditions, in this report. This report shall also include a notation of oil tank sump capacity and oil tank expansion space based on actual tests either in the airplane or on a test rig.

4.7 OIL DILUTION TESTS: The purpose of this test is to determine the effectiveness of the dilution system in the airplane installation.

4.7.1 Test Conditions -

a. Tests shall be conducted at the lowest practical ambient air temperature.

b. The oil tank shall be drained prior to any dilution tests and refilled to 75 percent of the normal oil capacity using oil as specified by the Chief of the Bureau of Aeronautics in Navy T.O. 37-54.

c. Prior to any test, the airplane shall either be ground run or flown for a short period so that the oil in the main portion of the oil tank shall be at least 40°C (104°F). The oil may be cooled to maintain an engine oil temperature as indicated on the pilot's temperature gage of between 30° - 50°C (86 - 122°F). This cooling may best be provided by temporarily altering the oil cooler temperature control setting so as to provide full cooling at all times by the installation of a spring loaded valve, or by wiring the shutters in the full open position.

d. Dilution shall be accomplished when the engine is idling at 1000 - 1200 RPM.

e. Dilution of turbo lubrication systems, boost controls, turbo regulators, etc. shall not be accomplished during the conduct of the dilution runs.

f. When securing any samples from drains, it is absolutely necessary to clear out the stagnant oil which may be caught in such drains before taking the sample.

4.7.2 Instrumentation - The instrumentation shall be as follows:

a. Aircraft instrumentation as contained in the airplane is sufficient.

b. An oil tank level gage, or stick, is required for determining changes in oil level.

4.7.3 Procedure - The tests shall be as follows:

4.7.3.1 When the test conditions outlined in paragraph 4.7.1 are established, the dilution test shall be a series of runs as follows:

(1) Actuate the dilution switch for a $2\frac{1}{2} \pm \frac{1}{2}$ minute period, release the switch and run the engine on additional 15 - 30 seconds with no change in RPM, then stop the engine.

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(2) Measure the oil level in the tank.

(3) Obtain oil samples from the following:

"Y" (or equivalent) drain.

Oil Tank - through filler neck (one sample from tank top and one from tank bottom).

Engine Sump.

(4) Start the engine in the normal manner and repeat the above runs as many times as necessary to determine the number of dilution periods required to obtain 10, 15, 20, and 25 percent dilution.

(5) Determine diluent flow rate, with or without engine operating, by disconnecting the dilution lines at the "Y" (or equivalent) drain and measuring the flow through the dilution system with fuel boost pumps providing the fuel pressure. Record fuel pressure before and during flow of the diluent. The fuel pressure, before actuating the dilution switch should be at least 75% of the normal fuel operating pressure.

4.7.3.2 Take-Off tests shall be accomplished with oil, diluted to 20% by volume with fuel as specified in the engine model specification at any ambient air temperature. Take-off shall be accomplished within five minutes after starting the engine. (Grade 1100 oil shall be used in all reciprocating aircraft engines for operation at ground temperatures above +35°F. Grade 1065 oil shall be used in all reciprocating aircraft engines for operation at ground temperatures below +35°F. When using grade 1065 lubricating oil, inlet temperatures shall be maintained between 65°C (149°F) and 75°C (167°F) during operation to obtain proper engine lubrication and to prevent accumulation of moisture and volatile products of oxidation in the oil. If it is not possible to maintain these temperature limits, main oil pressure should be maintained within the normal operating range and oil temperature should be kept above 60°C (140°F). Grade 1065 oil will generally require preheat for starting below 0°F).

4.7.4 Data and Report -

4.7.4.1 The following readings shall be taken immediately before the dilution switch is actuated and at one (1) minute intervals during the dilution runs.

- (1) Time.
- (2) RPM.
- (3) Free Air Temperature.
- (4) Oil Temperature.
- (5) Oil Pressure.
- (6) Fuel Pressure.
- (7) Cylinder Head Temperature.

4.7.4.2 During the take-off test, check and record any discharge from the engine breather and any indication of improper scavenging.

4.7.4.3 The test data and report shall be the basis for determining the dilution periods required to dilute the oil system 10, 15, and 20 percent.

4.7.4.4 The test report shall include the customary information, conclusions and recommendations that would normally be included in any technical report, including a description of airplane, engine, type of oil, method of determining percentage dilution, and oil conditions and factors peculiar to the test.

4.7.4.5 The complete test data shall be reported in a graph form with the percent dilution, oil pressure, cylinder head or coolant temperature, oil temperature, and

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boil-off time as ordinates, plotted against time of dilution as abscissa. Tabulate fuel pressures, actual time, oil tank levels, RPM, free air temperature, etc., as applicable. In plotting the curve of dilution against time, the shut-down time and small amount of additional running shall be ignored. Plot dilution of all samples taken, differentiating between points. Plot all points and connect by straight lines.

4.8 Oil Cooler Control Tests - The purpose of the test is to determine satisfactory operation of the oil cooler controls.

4.8.1 Test Conditions - Same as those under paragraph 4.6.

4.8.2 Instrumentation - The instrumentation shall be the same as called out in paragraph 4.6.2 above.

4.8.3 Procedure - Flights shall be made at any altitude at both 65% power and normal rated power to determine the stabilized oil temperature maintained by the oil cooler controls. Each flight shall be of 15 minutes duration or more. Airplanes having oil temperature controlled oil cooler flaps or other air restricting devices shall be flown first with these devices operating normally and then with these devices set wide open to permit the oil cooler thermostatic valve to operate.

4.8.4 Data - Oil cooler control data shall be obtained at five minute intervals during each test. All data obtained, with the exception of blower setting and mixture setting which will be tabulated, shall be plotted against time and included in the lubrication system report.

4.9 Reports -

4.9.1 The test report shall contain the following items:

- (1) All data required by the individual test.
- (2) The customary information, conclusions and recommendations that would normally be incorporated in any technical report, including a description of all conditions and factors peculiar to the test.
- (3) Specific information as follows: The airplane Type and Serial Number, the engine Type and Serial number, the total hours of operating time on the airplane and engine at the start of the test, the octane rating and grade of the fuel, grade and specification number of the engine oil, the type and serial number of the propeller, data on any particular conditions such as the presence or absence of external bomb load, propeller cuffs, cooling fans and any other items which may effect cooling or drag, a description of any conditions such as cowling modifications made during the tests, and the statement of the oil cooler core relief valve pressure.
- (4) A description of any instrumentation and installations that do not conform with the requirements of the tests, a statement of when the instruments were calibrated and preferably a descriptive list of the instruments and their calibration data.
- (5) Photographs, drawings, and sketches where applicable and of informative value.

4.9.2 Upon completion of the tests applicable to the particular airplane, a final report shall be submitted with full details of the tests and the results obtained. This report shall follow as nearly as practicable the logical sequence and the headings and sub-headings of the tests as outlined herein.

5. PREPARATION FOR DELIVERY: Not applicable.

6. NOTES

6.1 INTENDED USE: Material and design requirements covered in this specification are intended for use by aircraft manufacturers designing and producing aircraft for BuAer.

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6.2 Definitions.

6.2.1 Critical Altitude, Airplane (For Table II) - The reciprocating engine airplane critical altitude for a designated engine BHP is herein defined as the highest altitude at which the engine will develop the designated engine BHP in level flight without exceeding turbo supercharger and engine model limitations as specified by the turbo supercharger and engine model specifications. The jet engine airplane critical altitude for a designated thrust is herein defined as the highest altitude at which the engine will develop the designated thrust in level flight without exceeding the engine model limitations as specified in the applicable engine specifications.

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

TABLE I

No.		Remarks
1.	Engine Oil Pump Pressure	Inlet suction in oil supply line to engine at pump inlet; and engine lubrication pressure.
2.	Oil Cooler Inlet Pressure	At oil inlet.

NOTE: These pressures shall be obtained for all engine installations (i.e., both reciprocating and turbo types).

TABLE II

Test No.	Condition	Altitude	Power	RPM	Mixture (a)	Cowl Flaps (b)
1.	Climb (c)	-----	MIL.	MIL.	Auto Rich	Normal
2.	Level (d)	Highest	65% N.R.	Min.	Auto Lean	Normal
3.	Level	Highest Critical	MIL.	MIL. Allow.	Auto Rich	Normal
4.	Level	2000'	MIL.	MIL.	Auto Rich	Normal

- (a) Alternate terminologies "Rich/Normal" or "Full Rich"/Cruising Lean" may be encountered in some cases.
- (b) Normal cowl flaps and shutter settings shall be that position which will provide cooling on a Navy Hot Day as specified in the applicable airplane specification.
- (c) Climb shall be conducted as the airspeed of maximum rate of climb and shall be continued to service ceiling of the airplane.

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- (d) Also conduct this cruise test in maximum drag condition of contemplated external tanks, bombs, torpedoes, etc.

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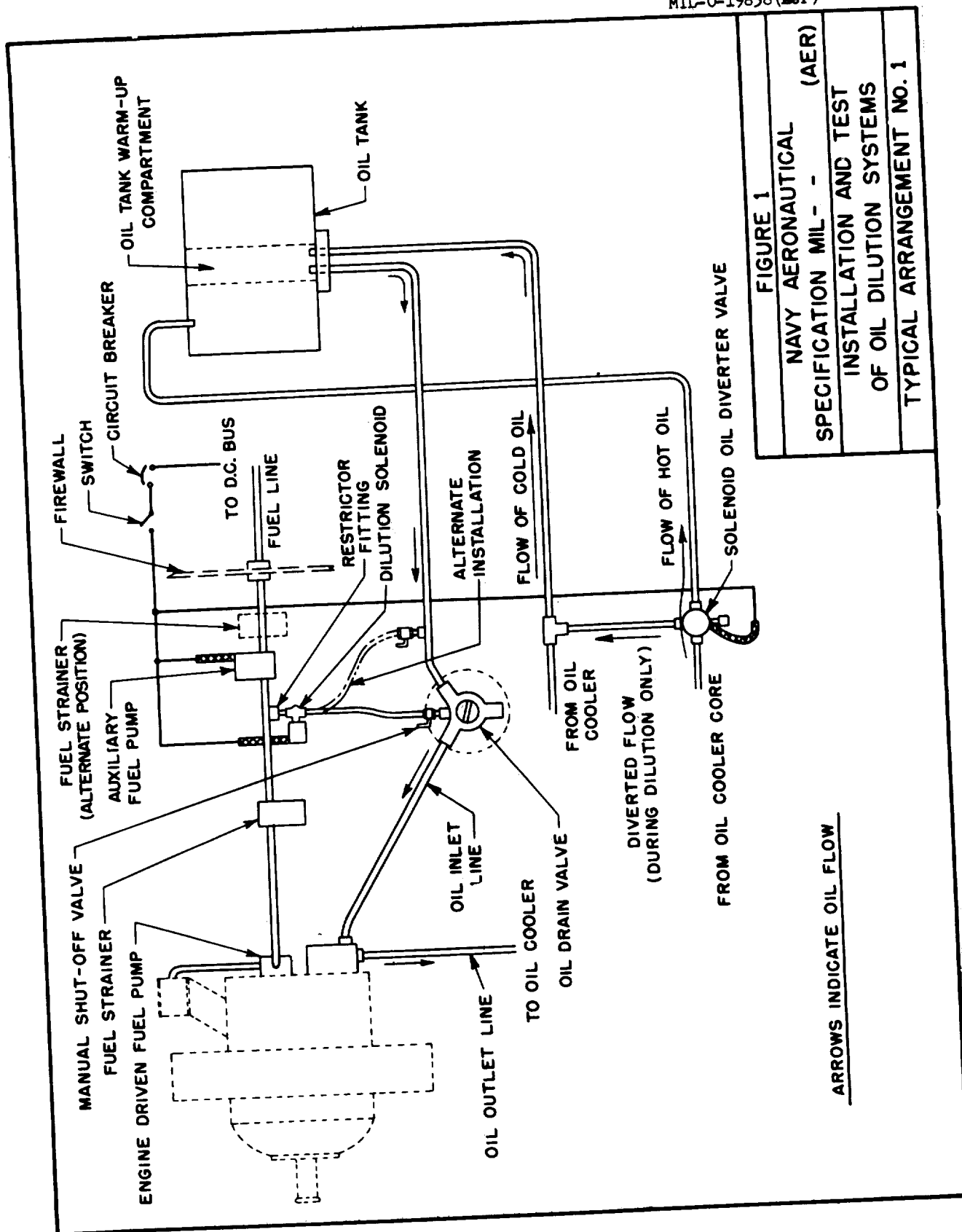


FIGURE 1

NAVY AERONAUTICAL
SPECIFICATION MIL - - (AER)
INSTALLATION AND TEST
OF OIL DILUTION SYSTEMS
TYPICAL ARRANGEMENT NO. 1

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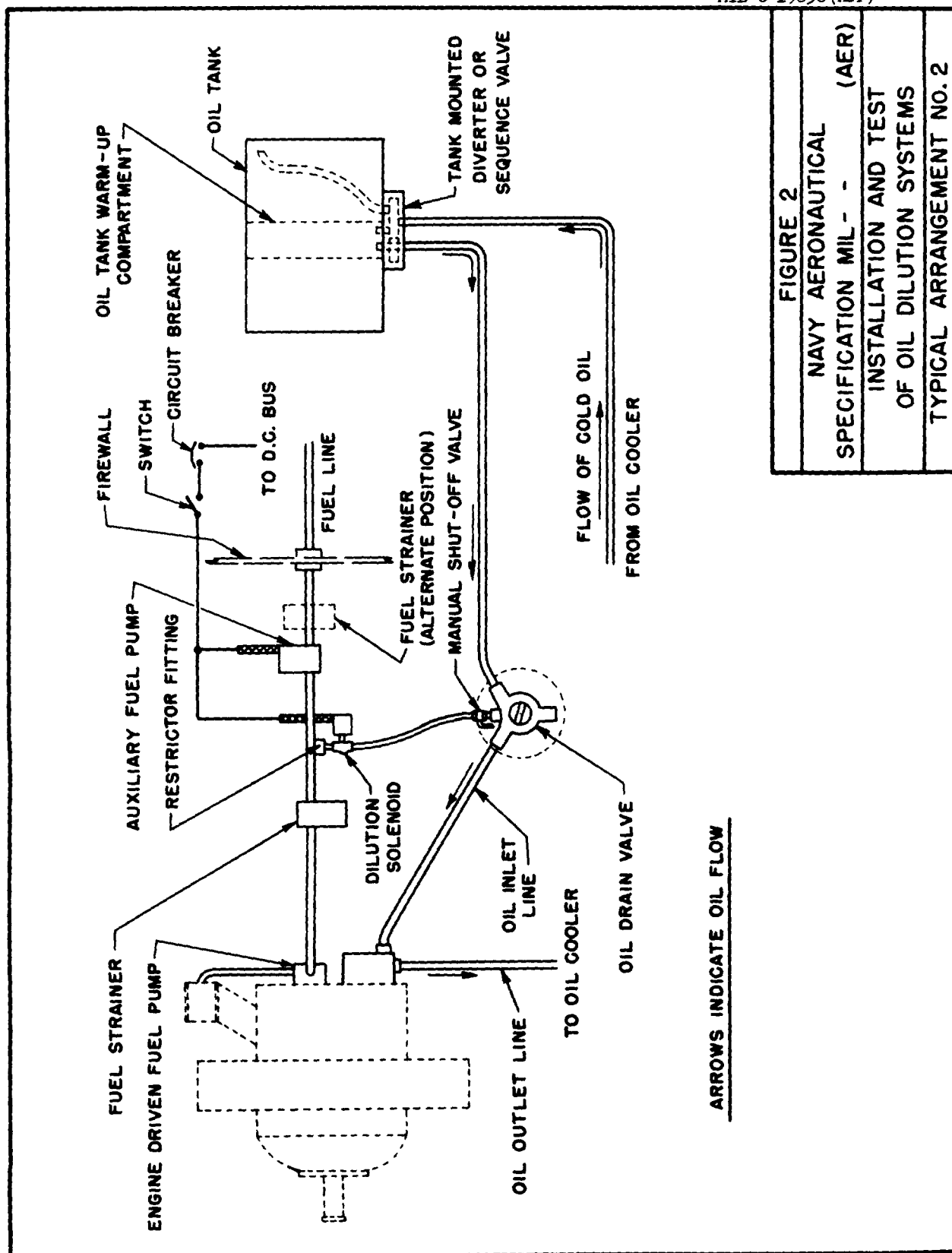


FIGURE 2
NAVY AERONAUTICAL
SPECIFICATION MIL - - (AER)
INSTALLATION AND TEST
OF OIL DILUTION SYSTEMS
TYPICAL ARRANGEMENT NO.2