MIL-F-8815D
27 September 1976
SUPERSEDING
MIL-F-8815C
29 September 1972

MILITARY SPECIFICATION

FILTER AND FILTER ELEMENTS, FLUID PRESSURE, HYDRAULIC LINE, 15 MICRON ABSOLUTE AND 5 MICRON ABSOLUTE, TYPE II SYSTEMS GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope - This specification covers hydraulic line filter assemblies and filter elements which retain all particles larger than 15 microns and 5 microns and are suitable for use as specified in 6.1, and the applicable specification sheet.

1.2 Classification - Hydraulic filter assemblies shall be of the following type, class, styles, micron ratings, and sizes, as specified (see 6.2). The hydraulic filter element shall be either cleanable or noncleanable as specified in the applicable specification sheet.

Type II (MIL-H-5440) - For -65°F to +275°F fluid temperature range
Class 3000 (MIL-H-5440) - Filter and filter element shall be furnished suitable for operating pressures up to and including 3,000 pounds per square inch (psi).
Styles, sizes, micron ratings, and part numbers shall be as specified in the applicable specification sheet.

2. APPLICABLE DOCUMENTS

2.1 Issue of documents - 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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 9311) Naval Air Engineering Center, Lakehurst, NJ. 08733 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 1650

SPECIFICATIONS

Federal

PPP-B-566	Boxes, Folding, Paperboard
PPP-B-636	Box, Fiberboard
PPP-B-676	Boxes, Setup

Military

MIL-P-116	Preservation, Methods of
MIL-B-117	Bag, Sleeve and Tubing-Interior Packaging
MIL-H-5440	Hydraulic Systems, Aircraft, Types I and II, Design, Installation, and Data Requirements For
MIL-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-H-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Testing
MIL-H-8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
MIL-H-25475	Hydraulic System, Missile, Design, Installation, Tests and Data Requirements, General Requirements for
MIL-F-81836	Filter and Disposal Element, Fluid Pressure, Hydraulic 3 Micron Absolute
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-794	Parts and Equipment, Procedures for Packaging and Packing of

Military (contd)

MIL-STD-810	Environmental Test Method
AN815	Union, Flared Tube
AN929	Cap Assembly, Pressure Seal Flared Tube Fitting
AND10064	Fittings, Installation of Flared Tube, Straight Threaded Connectors
63A109	Cleaning Machine Hydraulic Filter Element

PUBLICATIONS

Air Force

AFTM-T.O. 9H3-1-1	Cleaning and Testing Instructions for Woven Wire Hydraulic Filter Elements

(When requesting applicable documents, refer to both title and number. Copies of unclassified documents may be obtained from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. Requests for copies of classified documents should be addressed to the Naval Publications and Forms Center, via the cognizant Government representative).

* 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.

Society of Automative Engineers

ARP 598	Procedure for the Determination of Particulate Contamination of Hydraulic Fluids by the Particle Count Method
ARP 785	Procedure for the Determination of Particulate Contamination in Hydraulic Fluids by the Control Filter Gravimetric Procedure

(Application for copies should be addressed to the Society of Automative Engineers, 400 Commonwealth Drive, Warrendale, PA. 15096).

American National Standards Institute

ANSI Y14.5-1973 Dimensioning and Tolerancing for Engineering Drawings.

(Application for copies should be addressed to the American National Standards Institute, 10 East 46 Street, New York, New York 10017.)

National Aerospace Standards Association, Inc. Standard

NAS 1638 Cleanliness Requirements of Parts Used in Hydraulic Systems

(Applications for copies should be addressed to the National Aerospace Standards Association, Inc., 1321 Fourteenth St., N.W., Washington, D.C. 20005).

3. REQUIREMENTS

3.1 Specifications sheets - The individual part requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of conflict between the requirements of this specification and the specification sheet, the requirements of the specification sheet shall govern.

3.2 Qualification - The filter assemblies and filter elements furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 4.4 and 6.3). In addition, the retention of the qualification for the filter assembly and filter element on the applicable Qualified Products List shall be dependent on periodic verification of continued compliance with the requirements of this specification (see 4.3 (a) (1)).

3.3 General specification - The requirements of MIL-H-8775 apply as requirements of this specification with the exception and additions specified herein. When the two specifications conflict, this specification shall govern.

3.4 Materials -

3.4.1 Compatibility - The filter assemblies and filter elements shall be constructed of materials that will not adversely affect or be affected by hydraulic fluid conforming to MIL-H-5606, MIL-H-6083, MIL-H-83282, and the test fluid included herein.

3.4.2 Cleanable filter elements shall be constructed of materials that will not be adversely affected by the cleaning procedures specified in 4.7.2.6.2.3.

3.4.3 Process controls, limitations - If the filter element is of the type wherein resinous or other material is used for elimination of imperfections, not more than 5 percent of the filtering area shall be covered by the applied material. Filter element media having an initial bubble point of less than 3 inches of water before repair shall be cause for rejection. The manufacturer's qualification test report shall define the resin employed for joining or patching, application techniques, curing cycle, age limitation, and procedures followed to insure adhesion of the resin. The manufacturer's drawing shall specify the limitations or process controls that will govern manufacturing variations in media obstruction due to braze wicking, seam width, and crimp length in addition to the existing limits on repair.

* 3.4.4 Filter element repair procedures (For cleanable elements only) - Filter element repair procedures shall be submitted for approval to the activity responsible for qualification with the qualification test report. These repair procedures shall specify, but shall not be limited to the resin employed for joining or patching, application techniques, curing cycle, procedures to be followed to insure adhesion of the resin, and special tools and test equipment required.

3.4.5 Aging - Filter element materials that are subjected to aging shall be fully defined. Age limitation for these materials shall be specified in the qualification test report.

3.4.6 Fungi nutrients - Materials which are not nutrients for fungi shall be used wherever possible. Where fungus-nutrient materials must be used, they shall be treated with a fungicidal agent acceptable to the procuring activity.

3.5 Design and construction -

* 3.5.1 Filter assemblies and filter elements, for hydraulic systems conforming to MIL-H-5440 and MIL-H-25475, shall be designed and constructed as specified herein and in the applicable specification sheet. Filter assemblies shall be of such design and construction that the elements may be removed for service and inspection without disconnecting fittings or disturbing mountings. Filter assemblies shall be so designed that fluid entering the filter housing cannot impinge directly upon element filter medium or upon the relief valve poppet. The filter assemblies and filter elements shall be capable of withstanding 2,000 hours of operation at 275°F fluid and ambient temperature. The manufacturer shall

verify compliance with this requirement by analysis. Differential pressure indicators and pressure relief valves (except for the valve seat) shall be of a modular design and capable of being readily removed from the filter assembly for replacement.

3.5.2 Filter assemblies and filter elements shall be of the full-flow type. The flow through the filter elements shall be from "outside-in".

3.5.3 The design of filter assemblies shall be such that the filter element cannot be installed reversed.

3.5.4 Filter housings shall be designed to withstand all the structural loads imposed by the functional test requirements of this specification. In addition, the filter housing and mountings shall be of such strength and rigidity as to withstand the wrench loads required for making tube connections in accordance with AND10064 and the replacing of filter elements.

3.5.5 Interchangeability - It shall not be possible to interchange filter bowls and heads between the various sizes of filter assemblies, except that -4, -6, and -8 sizes shall use the same bowl.

3.5.6 Protective devices -

* 3.5.6.1 Filter element relief valves - Filter element pressure relief valve when required by the applicable specification sheet, shall meet the requirements of the applicable specification sheet and the requirements and tests specified herein (see 4.7.2.9).

3.5.6.2 Filter assembly relief valves - Style A filter assemblies shall incorporate a suitable relief valve to permit bypassing of the hydraulic fluid in the event of excessive restriction to flow through the filter element. The relief valve cracking pressure shall be 100 ± 10 psi. Reseat pressure shall be 65 psi minimum (see 4.7.1.3.1). These pressures apply over the full temperature range of -65° to +275° F. No relief valve shall be incorporated in style B filter assemblies.

3.5.6.2.1 The relief design shall be such that no malfunction can occur due to flow surges up to 150 percent of the rated flow of the filter. At 150 percent of rated flow through the relief valve and at 100° ± 10° F fluid temperature the differential pressure across the relief valve shall not exceed 240 psi.

3.5.6.2.2 The relief valve design shall be of the nonadjustable type.

3.5.6.2.3 With the filter assembly installed with the bowl below horizontal, the design shall incorporate provisions to prevent inborne contaminants from accumulating or settling where entrainment with relief valve flow will occur.

* 3.5.6.3 Differential pressure indicator - Filter assemblies shall incorporate an integral nonelectrical device that will give visual warning by raising a red indicator when the differential pressure across the element exceeds 70 ± 10 psid. Inadvertent actuating shall not occur under a temporary flow surge or a 20g shock load. External contamination shall not adversely affect the normal operation of the differential pressure indicator. If necessary (such as for low actuation force) design features shall be incorporated to provide the indicator pin with positive protection against external contaminants which might impede normal operation. Once actuated, the red indicator shall remain extended until reset manually. When the indicator is in the reset position, it shall be hidden from view. The indicator shall not actuate below 100° ± 15° F fluid temperature. The indicator shall be red in color.

3.5.6.4 Automatic shutoff - Styles A and B filter housings shall be provided with an automatic shutoff device to prevent drainage from the flow between the inlet and outlet ports of the filter head when the filter bowl and element are removed, and to prevent air inclusion in excess of 2 cc. upon reassembly. The device for style B filter housings, shall allow rated flow through the filter housing at a differential pressure not to exceed 200 psi in the event that the filter element is not installed in a filter assembly. The device shall pass the leakage, cycling, and air inclusion tests specified under 4.7.1.3.3.

3.6 Performance -

* 3.6.1 Filter assemblies, filter housings, and filter elements shall perform satisfactorily when subjected to the tests specified herein.

3.6.2 Impulse - Filter assemblies shall withstand 25,000 impulse cycles at 275° F fluid temperature and 75,000 impulse cycles at 225° F without evidence of leakage or structural failure.

3.6.3 Housing and element pressure drop - The maximum pressure drop at rated flow between the inlet and outlet of the filter housing only, shall not exceed 15 psi with a free-flow dummy element installed (see 4.7.1.2). The maximum pressure drop at rated flow across the filter element shall not exceed the value specified in the applicable specification sheet.

3.6.4 Burst pressure - Filter assemblies shall withstand a burst pressure of 7,500 psi.

3.6.5 Proof pressure - Filter assemblies shall withstand a proof pressure of 4,500 psi at 275°F fluid temperature.

3.6.6 Filtration - Filter element efficiency shall be as specified in the applicable specification sheet.

3.6.6.1 Filter element shall not unload when subjected to intermittent hydraulic pulsing or start up flow conditions as found in typical hydraulic systems.

3.6.6.2 Filter elements shall not be sensitive to variations in contaminant concentration, type and/or distribution above the absolute rating.

3.6.6.3 Filter elements shall be so designed that under normal handling the filter media will not be damaged or degraded.

3.6.6.4 Filter element filtering media construction shall be such that it is not affected by thermal cycling and pressure/flow cycling. Normal operation shall not cause continuous or sporadic release of the media, binder and adhesive if used.

* 3.6.7 Media migration - Filter assemblies shall withstand vibration frequencies in accordance with 4.7.2.8.3.2. There shall be no media migration traceable to the filter element or its packaging (See 4.7.2.8).

3.6.8 Element collapse - Filter elements shall withstand a differential pressure as specified in the applicable specification sheet.

3.6.9 Bubble point - The initial bubble point values shall meet the value established by the activity responsible for qualification and shall be determined as specified in 4.7.2.1.1. All elements submitted to the quality conformance bubble test shall meet the values established.

3.7 Markings -

3.7.1 Direction of flow - The direction of flow shall be clearly and permanently indicated by at least two arrows marked on opposite sides of the filter body.

3.8 Identification of product -

* 3.8.1 Filter housing - Each filter housing shall be clearly and permanently identified by steel stamping, electro-etching, or by a permanently attached nameplate conforming to MIL-STD-130. The following information shall be provided:

FILTER, FLUID PRESSURE, HYDRAULIC, 3,000 PSI (insert micron rating) MICRONS ABSOLUTE, MAXIMUM TEMPERATURE 275°F M8815/ (insert slash number of specification sheet and size dash number)
Manufacturer's part No.
Manufacturer's serial No.
Manufacturer's name or trademark
Replacement element M8815/ (insert slash number of specification sheet and size dash number)
Part number(s) preformed packing seals
Assembly torque for bowl

* 3.8.2 Filter element - Each filter element shall be clearly and permanently identified on one end by steel stamping, electro-etching, or by a permanently attached nameplate in accordance with MIL-STD-130. The method of marking shall be in accordance with MIL-STD-130. The marking shall not be placed on a sealing surface, the markings shall not affect the sealing of the element. The following information shall be provided:

M8815/ (insert slash number of specification sheet and size dash number)
Manufacturer's part No.
Manufacturer's serial No. (Cleanable elements only)
Manufacturer's Lot No. (Noncleanable elements only)
Manufacturer's name or trademark
Cleanable or noncleanable
Maximum pressure drop after cleaning (Cleanable elements only see 4.7.2.6.2.2.1)

3.8.3 Part numbering of interchangeable parts - The manufacturer's part number and drawing number shall be the same.

3.9 Workmanship - All details of workmanship shall be of a sufficiently high grade to insure proper operation.

4. QUALITY ASSURANCE PROVISIONS

4.1 General - The quality assurance provisions shall be in accordance with MIL-H-8775 and as specified herein.

* 4.2 Responsibility for inspection - Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 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.

4.3 Classification of tests - The inspection and testing of filters shall be classified as follows:

(a) Qualification tests (4.4)

(1) Retention of qualification - Retention of qualification consists of a periodic verification to determine compliance of the qualified product with the requirements of this specification (see 3.2 and 4.4.4).

(b) Quality conformance inspection (4.5).

4.4 Qualification tests -

4.4.1 Filter housing -

4.4.1.1 Samples for qualification tests of filter housings shall consist of two specimens of each device upon which qualification is desired.

4.4.1.2 The specimens shall be assembled of parts which conform to manufacturer's drawings.

4.4.1.3 The manufacturer shall provide calculations showing that adequate clearance of moving parts is provided at -65° and +275° F, using the most adverse dimensions. The room temperature reference point shall be 70° F.

4.4.2 Filter elements -

4.4.2.1 Qualification test samples of filter elements (cleanable and noncleanable) shall consist of eight elements of each size upon which qualification is desired. Manufacturer's qualification tests shall not have been performed on these samples. The manufacturer shall submit reports of the qualification tests on other specimens of the same design. A submittal procedure similar to that outlined for filter housings shall then be followed.

4.4.2.2 If the elements are of the type in which repair material is applied to eliminate imperfections, the qualification test elements shall have a minimum of 5 percent of the filtering area repaired. The areas repaired shall contain at least three imperfections whose initial bubble point is 3 inches of water or less.

4.4.3 Tests - The qualification tests shall consist of the tests specified under 4.7, conducted on the applicable specimens, in the order specified in Table I.

* 4.4.4 Retention - The retention of qualification shall consist of periodic verification to determine compliance of the qualified filter assembly and filter element with the requirements of this specification and applicable specification sheet. Verification shall be conducted at intervals not exceeding 2 years.

4.5 Quality conformance inspection - Quality conformance inspection shall consist of the following:

(a) Individual inspection (4.5.1)

(b) Sampling tests (4.5.2)

4.5.1 Individual inspection - The individual inspection, specified in Table II, shall be conducted on each filter housing and filter element in that order. Any filter housing or filter element containing a defect shall be rejected.

* 4.5.2 Sampling tests - A sample shall be selected from each inspection lot (see 4.5.3) in accordance with MIL-STD-105 using special inspection level S-1 with no rejects allowed. The sample filter assemblies and filter elements shall be unpacked and the sampling tests, specified in Table II, shall be conducted on each filter assembly and filter element in that order. For filter elements one half of the samples shall be subjected to the pressure buildup and collapse test and one half of the samples shall be subjected to the degree of filtration test. When the total number of samples is an odd number, the odd sample shall be subjected to the pressure buildup and collapse test.

4.5.2.1 Cleanliness - To assure that the filter elements and housing are being cleaned properly, and to assure that the parts are not contaminated during packaging, sample filter elements or assemblies shall be unpacked and tested for cleanliness as specified in paragraphs 4.5.2.1.1 and 4.5.2.1.2. Filter elements shall be installed in a precleaned housing.

* TABLE I. Qualification Tests

Filter assembly	Reference
Examination of product	(See MIL-H-8875)
Proof pressure	4.7.1.1.1
Housing pressure drop	4.7.1.2
Protective devices	4.7.1.3
Extreme temperature	4.7.1.4
Proof pressure	4.7.1.1.1
Media and abrasion migration	4.7.2.8
Impulse	4.7.1.5
Protective devices 1/	4.7.1.3
Burst pressure	4.7.1.6
Filter Element No. 1 (lowest bubble point)	Reference
Examination of product	(See MIL-H-8775)
Bubble point	4.7.2.1.1.1
Immersion	4.6.3
Bubble point	4.7.2.1.2
Cold start	4.7.2.3
Bubble point	4.7.2.1.2
Maximum particle passed	4.7.2.5
Bubble point	4.7.2.1.2
Flow fatigue	4.7.2.7
Bubble point	4.7.2.1.2
Filter Element No. 2 (Highest bubble point)	Reference
Examination of product	(See MIL-H-8775)
Bubble point	4.7.2.1.1.1
Immersion	4.6.3
Bubble point	4.7.2.1.2
Cold start	4.7.2.3
Bubble point	4.7.2.1.2
Pressure buildup and collapse	4.7.2.6
Bubble point	4.7.2.1.2
Relief valve operation (if applicable)	4.7.2.9

TABLE I. Qualification Tests (Cont'd)

Filter Element No. 3 (2nd lowest bubble point)	Reference
Examination of product	(See MIL-H-8775)
Bubble point	4.7.2.1.1.1
Immersion	4.6.3
Bubble point	4.7.2.1.2
Cold start	4.7.2.3
Bubble point	4.7.2.1.2
Degree of filtration	4.7.2.4
Bubble point	4.7.2.1.2
Filter Element No. 4	**Reference**
Examination of product	(See MIL-H-8775)
Bubble point	4.7.2.1.1.1
Immersion	4.6.3
Bubble point	4.7.2.1.2
Flush	4.7.2.2
Cold start	4.7.2.3
Bubble point	4.7.2.1.2
Media and abrasion migration	4.7.2.8
Bubble point	4.7.2.1.2

1/ Make functional checks only one time, omitting any required repeated cycling.

*TABLE II. Quality Conformance Tests

Individual test	Reference
Filter Housing	
Examination of product	(See MIL-H-8775)
Proof pressure	4.7.1.1.2
Protective devices	
Relief valve	4.7.1.3.1.2
Differential pressure indicator	4.7.1.3.2.2
Automatic shutoff	4.7.1.3.3.1.2
Filter elements only	
Examination or product	(See MIL-H-8775)
Quality conformance bubble point	4.7.2.1.2
Filter Element pressure drop (cleanable elements)	4.7.2.6.2.1
Filter element relief valve (if applicable)	4.7.2.9.2

TABLE II. Quality Conformance Tests (Cont'd)

Sampling tests	Reference
Filter assemblies and filter elements	
Cleanliness	4.5.2.1
Filter elements	
Pressure buildup and collapse (One loading only to applicable pressure drop specified in Table I of specification sheet - no samples taken)	4.7.2.6
Degree of filtration (Filter element efficiency)	4.7.2.4

4.5.2.1.1 Vibration - The filter assembly, filled with the test fluid, shall be vibrated for 15 minutes at a frequency of 120 ± 10 cps and a double amplitude of 0.014 inch in a direction parallel to the bowl axis of the assembly.

4.5.2.1.2 Degree of cleanliness - The filter assembly shall be transferred to a stand and flush with 2,000 milliliters of prefiltered hydraulic test fluid at rated flow, and the effluent collected. The contaminant level of the effluent sample shall be determined in accordance with ARP 785. The contaminant value obtained shall not exceed 1.75 milligrams maximum.

* 4.5.3 Inspection lot - For purposes of quality conformance inspection, a lot shall be defined as all filter assemblies manufactured under essentially the same conditions and offered for acceptance at one time, or all filter elements manufactured from one convoluter set-up. Elements manufactured in excess of contract quantity may be placed in stock and accepted for later contracts (within 3 years) based on prior tests of the specific lot.

4.5.4 Report of failure of sampling test - When a filter element fails to pass a sampling test, the entire lot represented shall be rejected. All failure of the tested units and elements shall be reported immediately by telephone or message. Full particulars concerning previous similar failures, the current failures and action taken to correct the defects shall be submitted to the procuring agency in writing. The lot represented by the unsatisfactory sample shall not be resubmitted until approval of resubmission has been issued by the procuring agency.

4.6 Test conditions -

4.6.1 Test fluid - Unless otherwise specified, the hydraulic fluid used for all tests shall conform to MIL-H-5606 (with no free water). For quality conformance tests, hydraulic fluid conforming to MIL-H-6083 or MIL-H-5606 (with no free water) may be used.

* 4.6.1.1 Test fluid cleanliness - For quality conformance tests and critical qualification tests the test fluid shall be precleaned to a cleanliness level equal to class 1 of NAS 1638.

* 4.6.1.2 Test fluid filtration - Unless otherwise specified, the test fluid shall be continuously filtered through a 3-micron absolute filter conforming to MIL-F-81836(AS) or a filter with equivalent efficiency during testing.

4.6.1.3 Test fluid temperature - Unless otherwise specified, the actual temperature of the test fluid shall be 100° ± 10° F.

4.6.2 Temperature - Unless otherwise specified, the tests shall be conducted at a room temperature of 70° to 90° F, measured within 12 inches of the test sample.

4.6.3 Immersion - Prior to performing the qualification tests, filter elements shall be immersed in hydraulic fluid (see 4.6.1) for a period of 72 hours at a fluid temperature of 275° F and 72 hours at a fluid temperature of -65° F. All internal parts shall be in contact with the test fluid during this period. After immersion, the filter shall remain in this fluid at room temperature until further tests are conducted.

4.6.4 Test air - The air used to pressurize the test apparatus shall be filtered through a 0.45-micron membrane filter (type HA Millipore, or equivalent).

4.6.5 Weight, measurement of -

4.6.5.1 Precision (of weighing) - Unless otherwise specified, all weights shall be measured with a precision of one part in one thousand or better.

4.6.5.2 Static electricity, elimination of - A device to eliminate static electricity shall be in proximity to the filter membrane disc, or to the pan on which it rests, whenever any object or material is being weighed to a precision of ± 0.1 gram or finer. The age of the device shall not exceed the value stated by the manufacturer as its rated service life.

* 4.6.6 Test dust, source of supply - All test dust used for tests shall be obtained from the Naval Air Development Center (NADC), (Attention of Code 30211), Warminster, Pa. 18974, and shall be the lot of test dust currently in use at NADC.

4.7 Test methods -

4.7.1 Filter assembly -

4.7.1.1 Proof pressure -

* 4.7.1.1.1 Proof pressure (Qualification) - Filter assemblies shall withstand proof pressure as specified herein without evidence of permanent deformation, malfunction, or external leakage. The filter assembly shall be filled with test fluid and maintained at 275° F for 72 hours. Proof pressure of 4,500 psi shall then be applied at least twice while at 275° F and held for 2 minutes at each application. The pressure shall be reduced to zero between applications. The activity responsible for qualification shall have the prerogative to conduct additional tests to validate compliance of the filter assemblies with the longevity requirements specified in 3.5.1, and verify the manufacturer's analysis.

* 4.7.1.1.2 Proof pressure (quality conformance) - Proof pressure (4,500 psi) shall be applied at least twice at room temperature and held for 2 minutes at each application. The pressure shall be reduced to zero between pressure applications. There shall be no evidence of permanent deformation, malfunction or external leakage.

* 4.7.1.2 Housing pressure drop - This test shall be conducted with a free-flow dummy element installed to hold open the automatic shutoff. The free-flow dummy element shall be constructed in accordance with the applicable filter element specification sheet with the X dimension being held to the minimum diameter shown. The filter manufacturer shall have the prerogative to furnish this test dummy with filtration media representing minimum pressure drop. With rated flow applied to the filter housing, the pressure drop shall not exceed 15 psi.

4.7.1.3 Protective devices - A suitable means of stopping flow through the filter element port shall be installed for this test.

4.7.1.3.1 Relief valve operation -

4.7.1.3.1.1 Qualification - Style A filter housings shall be tested for relief valve operation. By means of a power-driven pump, pressure shall be applied to the inlet port of the filter housing, beginning with a pressure of 70 psi and increasing in increments of 10 psi or less until cracking pressure of the relief valve in the filter housing being tested is reached. At each increment, the pressure shall be maintained constant for 5 minutes. At each pressure increment, time shall not be considered "in" or leakage noted until the beginning of the third minute. The leakage rate during the last 3 minutes of each pressure increment shall be noted. The pressure at which the leakage rate through the relief valve amounts to 8 cubic centimeters (cc.) (approximately 160 drops) per minute shall be considered as cracking pressure. Cracking pressure shall occur at 100 $\pm$ 10 psi. Leakage up to 80 psi shall not exceed 4 cc. (approximately 80 drops) per minute. Pressure shall be increased until rated flow through the relief valve is obtained. Rated flow shall occur at a pressure differential between inlet and outlet ports not exceeding 160 psi. The pressure shall be reduced to 10 psi decrements as above until leakage through the relief valve does not exceed the rate of 4 cc. per minute. The resulting pressure shall be considered the relief valve reseating pressure and shall occur at a pressure of 65 psi or above. The flow through the relief valve shall be raised to 150 percent of rated flow. The differential pressure across the relief valve shall not exceed 240 psi.

4.7.1.3.1.1.1 Relief valve contamination tolerance test - Style A filter housings shall repeat the Qualification test of 4.7.1.3.1.1 with the fluid contaminated to a level of 100 mg/l with A.C. Fine Test Dust. The cracking, full flow and reseat cycle shall be applied for a total of 100 cycles. At the end of each cycle, the flow shall be reduced to zero prior to commencing the next cycle. Malfunction or relief valve damage shall constitute failure of this test.

4.7.1.3.1.2 Quality conformance -

(a) Style A filter housing shall be tested for relief valve operation. By means of a power-driven pump, pressure shall be applied to the inlet port of the filter housing. At each pressure increment, the pressure shall be maintained constant for 3 minutes except that, for the first increment, adequate time shall be allowed to permit all cavities to fill with fluid and steady state conditions to be obtained.

(b) The pressure at the inlet port shall initially be raised to 90 psi. If steady state leakage through the relief valve is less than 4 cc. (approximately 80 drops) per minute, the test shall be continued with item (d).

(c) If leakage is between 4 cc. (approximately 80 drops) and 8 cc. (approximately 160 drops) per minute, the inlet pressure shall be dropped below 65 psi and then raised to 80 psi. Leakage at 80 psi shall not exceed 4 cc. per minute.

(d) The inlet pressure shall then be raised to 110 psi. Flow through the relief valve shall exceed 8 cc. per minute. The inlet pressure shall be further increased to produce a flow of at least 25 percent of rated flow through the relief valve. This pressure shall be below 150 psi. The inlet pressure shall then be reduced to 65 psi. Leakage through the relief valve shall be less than 4 cc. per minute.

4.7.1.3.1.3 Relief valve cycling test in style A housings - The filter housing relief valve shall be subjected to a cycling test as follows: With the outlet port open, and an effective means for stopping flow through the filter element installed, the relief valve shall be cycled 2,000 times from zero to 150 percent of rated flow and back at 100° ±10° F. There shall be no malfunction of any of the relief valve parts during this test. Upon completion of the cycling test, the relief valve shall meet all the requirements of the relief valve operating test with the exception that the leakage up to 80 psi shall not exceed 5 cc. (approximately 100 drops) per minute.

* 4.7.1.3.2 Differential pressure indicator operation - For all tests where indicator operation is required the ambient and fluid temperature shall be at 120° F minimum unless otherwise specified to insure the release of the thermal lockout mechanism. Alternate test procedures must be approved by the activity responsible for qualification (6.3) prior to implementation. For Shock test (4.7.1.3.2.1.5) and media and abrasion migration (4.7.2.8.3.2) the thermal lockout mechanism shall be inactivated or the test conducted with an ambient and fluid temperature of 120° F minimum.

* 4.7.1.3.2.1 Qualification -

* 4.7.1.3.2.1.1 Pressure actuation - Styles A and B filter housings shall be tested for differential pressure indicator operation with the element port plugged and outlet vented to atmosphere. By means of a power-driven pump, the pressure shall be slowly increased at the inlet port of the filter housing until the pressure indicator actuates fully and locks. This shall be considered the indicator operating pressure. The indicator operating pressure shall occur at 70 ± 10 psid. The pressure shall then be raised to 4,500 psi and dropped to zero psi. The indicator

shall stay locked in the extended position throughout the pressure range of zero to 4,500 psi. The indicator shall then be manually reset. For style A filter housings, the relief valve shall be blocked. This test shall be repeated at a fluid and ambient temperature of 80° F. No actuation shall occur.

* 4.7.1.3.2.1.2 Low system pressure cycling - With the filter element port plugged and the outlet port vented to atmosphere, the pressure shall be increased at a rate of 20 psi per minute at the inlet port of the filter housing, until the pressure indicator actuates fully. This shall be considered the indicator operating pressure, and shall occur at 70 ± 10 psid. The inlet pressure shall then be reduced to zero and the indicator manually reset. The pressure shall then be cycled 1,000 times at any practical cycling rate from zero to 80 psi and back to zero psi. The indicator shall actuate and shall be reset at the end of each cycling and shall occur at 70 ± 10 psid.

* 4.7.1.3.2.1.3 High system pressure cycling - The filter element port shall be blocked with a plug containing an orifice designed to provide rated flow at 80 psi differential pressure across the orifice. The outlet port of the filter housing shall be throttled to provide rated flow through the orifice at 3,000 psi inlet pressure. The flow shall be cycled from zero to rated flow and the differential pressure at which the indicator actuates fully shall be noted. This shall occur at a differential pressure of 70 ± 10 psid. The inlet pressure shall then be raised to 3,000 psi and dropped to zero psi. After actuation, the indicator shall remain in the extended position. The indicator shall then be manually reset. This cycle shall be repeated 1,000 times. The differential pressure indicator operating pressure at 3,000 psi inlet pressure shall then be rechecked and shall occur at 70 ± 10 psid.

4.7.1.3.2.1.4 Flow surge - Styles A and B filter housings shall be tested for inadvertent differential pressure indicator operation due to a temporary flow surge. The filter element port shall be blocked. With a power-driven pump and a quick opening valve the pressure shall be rapidly raised from 0 to 80 psi. The differential pressure indicator shall not actuate during the first 0.1 second of pressure application. The differential pressure indicator shall actuate within 1 second from the start of pressure application. The test shall be repeated at 200, 300, 400, and 500 psi and the differential pressure indicator shall actuate within the specified 0.1 to 1 second time range. For Style A filter housings, the relief valve shall be blocked for the foregoing test.

4.7.1.3.2.1.5 Shock - Styles A and B filter assemblies shall be subjected to 12 impact shocks of 20g. Each shock impulse shall have a time duration of $10^{\pm}$ 1 milliseconds. The maximum g shall be reached in approximately 5 milliseconds. The shocks shall be applied in each of the three principal filter assembly axes with the differential pressure indicator in an extended and retracted position. The differential pressure indicator shall remain in its original extended or retracted position during the tests. The shock test shall not have any detrimental effect on the differential pressure indicator relief valve or automatic shutoff.

4.7.1.3.2.1.6 Dust test - Styles A and B filter assemblies shall be subjected to dust test procedure in accordance with method 510.1 of MIL-STD-810. The indicator operating pressure shall be checked in accordance with 4.7.1.3.2.1.1 following this test and shall occur at 70 ± 10 psid.

4.7.1.3.2.1.7 Salt fog - Styles A and B filter assemblies shall be subjected to salt fog test procedure in accordance with method 509.1 of MIL-STD-810. The differential pressure indicator shall be checked in accordance with 4.7.1.3.2.1.1 before removing any salt deposits and again after rinsing with water. The indicator shall actuate at 70 ± 10 psid.

4.7.1.3.2.2 Quality conformance - Styles A and B filter housings shall be tested for differential pressure indicator operation with the element port plugged. With the ambient and fluid temperature stabilized at 80° F maximum, a pressure of 80 psi shall be applied by a power-driven pump to the inlet port of the filter, with the outlet port vented. The indicator shall not actuate. Release the pressure. Stabilize the ambient and fluid temperature at 120° F minimum and apply a pressure of 59 psi. The indicator shall not actuate. Increase the pressure to 80 psi and the indicator shall actuate during this pressure rise from 60 to 80 psi. Reduce pressure to 0 and the indicator shall remain in the actuated position. Depress button manually and button shall remain depressed.

4.7.1.3.3 Automatic shutoff - The following tests shall be performed on styles A and B filter housings.

4.7.1.3.3.1 Leakage -

4.7.1.3.3.1.1 Qualification - A pressure of 5 psi shall be applied simultaneously to both ports of the filter assembly. The bowl and filter element shall be disengaged, removed, and the excess fluid shall be removed from the lower surface of the filter housing head. The leakage measurement period shall be 30 minutes in duration and shall begin 2 minutes after removal of excess fluid. The foregoing test shall be repeated using a pressure of 200 psi. There shall be no measureable leakage during this test.

4.7.1.3.3.1.2 Quality conformance - A pressure of 5 psi shall be applied simultaneously to both ports of the filter assembly. The bowl and filter element shall be disengaged, removed, and the excess fluid removed from the lower surface of the filter housing head. The leakage measurement period shall be 2 minutes in duration after removal of excess fluid. The foregoing test shall be repeated, using a pressure of 200 psi. There shall be no measurable leakage during this test.

4.7.1.3.3.2 Cycling - With a test fluid pressure of 200 psi applied simultaneously to both ports of the filter assembly, the bowl and filter element shall be disengaged, removed, and reinstalled a total of 500 times. No malfunction of the shutoff device shall occur as a result of this cycling. At the conclusion of the cycling, the shutoff device shall pass the leakage test (see 4.7.1.3.3.1). The filter head, bowl, and filter element shall be inspected and shall show no signs of excessive wear. Filter bowl and filter element seals may be replaced periodically for ordinary wear, and shall not exhibit damage due to cutting or pinching.

4.7.1.3.3.3 Air inclusion - Calculations shall be included as part of the test report indicating the maximum possible air inclusion, assuming that the filter bowl is completely filled with fluid prior to assembly. The maximum calculated air inclusion shall not exceed 2 cc.

* 4.7.1.3.3.4 Flow assurance - With the filter element removed and the filter bowl installed, pressure shall be applied to the flow inlet port of the filter assembly by means of a powerdriven pump, until rated flow occurs from the outlet port. The differential pressure through the filter housing shall not exceed 200 psi.

4.7.1.4 Extreme temperature - The following tests shall be performed on styles A and B filter housings, as applicable.

* 4.7.1.4.1 Style A - With the filter element port blocked, style A filter housings shall be subjected to a temperature of -65° to -70° F for 24 hours. During this period, pressure applied shall not exceed 10 psi. At the end of this period, operation of the relief valve shall be checked for cracking and reseat only. Proof pressure shall then be applied simultaneously at both ports for 2 minutes. The temperature of the hydraulic fluid used for these tests shall be -65° to -70° F. Within 20 minutes, the filter housing shall be removed from the cold box and placed in an ambient temperature of 275° F. A pressure of 80 psi shall be applied to the inlet port with the outlet port vented to atmosphere. The fluid temperature

at which the differential pressure indicator actuates shall be measured and shall be 100 ± 15° F. The indicator operating pressure and relief valve cracking and reseat pressure shall be checked at 5, 10 and 60 minutes, and 24 hours following the first indicator actuation. Indicator operating and relief valve cracking and reseat pressures shall be within the ranges specified in 4.7.1.3.1 and 4.7.1.3.2.1.1.

4.7.1.4.2 Style B - With the element port blocked, style B filter housings shall be subjected to a temperature of -65° to -70° F for 24 hours. During this period, pressure applied shall not exceed 10 psi. At the end of this period, a pressure of 80 psi shall be applied to the inlet port of the unit and held for 10 minutes, with the outlet port vented to atmosphere. Proof pressure shall then be applied to the inlet port for 2 minutes. The temperature of the hydraulic fluid used for these tests shall be -65° to -70° F. Within 20 minutes, the filter housing shall be removed from the cold box and placed in an ambient temperature of 275° F. A pressure of 80 psi shall be applied to the inlet port of the unit with the outlet port vented to atmosphere. The fluid temperature at which the differential pressure indicator actuates shall be measured and shall be 100 ± 15° F. The indicator operating pressure shall be checked at 5, 10 and 60 minutes, and 24 hours after the first indicator actuation. Indicator operating pressure shall be within the range specified in 4.7.1.3.2.1.1.

4.7.1.5 Impulse - Filter assemblies shall be subjected to 100,000 impulse cycles, 25,000 at a fluid temperature of 275° F and 75,000 at a fluid temperature of 225° F. Each impulse cycle shall consist of a pressure rise from zero to 3,000 psi and drop to zero. During each pressure increase, a peak surge pressure of 1.43 to 1.57 times the working pressure, as shown by an oscillograph, shall be obtained. Cycling shall be performed at a rate of 300 cycles per minute (cpm) maximum. There shall be no evidence of external leakage of structural failure during the performance of this test. See Figure 2 for impulse curve. The differential pressure indicator shall not actuate during the impulse test. The actual impulse pattern shall be recorded and reported.

* 4.7.1.6 Burst pressure - Pressure shall be applied at a maximum rate of increase of 25,000 psi per minute until the specified burst pressure of 7,500 psi is reached. Filter housings shall show no leakage in the form of drops or rupture of internal or external parts at this pressure when held for 2 minutes. The pressure may be increased above that specified during qualification tests in order to secure data on actual burst pressure. The test shall be conducted at 275° F after a 5-hour soak at 275° F with the filter housing filled with test fluid.

4.7.2 Filter elements -

* 4.7.2.1 Bubble point -

* 4.7.2.1.1 Bubble point qualification - Filter elements shall be tested to determine the initial bubble point. The filter element, containing no fluid, shall be installed in a setup similar to Figure 3. The fluid level shall be maintained at approximately 1/2 inch above the top of the filter element. The air pressure, as indicated in inches of water on the manometer, shall be slowly raised by small increments. The filter element shall be rotated 360 degrees about its longitudinal axis at each increment of air pressure so that the entire filter area can be observed for the appearance of the first bubble. The area of greatest porosity is determined by observing the first bubble on the surface of the filter element; and the manometer reading in inches of water at which this bubble emits from the filter element shall be recorded. This test shall be accomplished within a period of 10 minutes after immersion in the fixture. The fluid used shall be Proprietary Solvent #3 (U.S. Industrial Chemicals), or equivalent, at 70° ± 5° F filtered through 0.45-micron membrane Millipore filter, or equivalent.

* 4.7.2.1.1.1 Minimum allowable initial bubble point - The maximum particle passed test (see 4.7.2.5) shall be performed on the element with the lowest bubble point. The minimum allowable initial bubble point shall be established from the maximum particle test element and shall be indicated on the qualification test report and filter element drawing. The degree of filtration test (see 4.7.2.4) shall be performed on the element with the second lowest bubble point, and the pressure buildup and collapse test (see 4.7.2.6) shall be performed on the element with the highest bubble point.

* 4.7.2.1.1.2 Bubble point after performance test - Where specified in Table I, a bubble point test shall be conducted in accordance with 4.7.2.1.1. The initial bubble point shall not be less than the minimum allowable initial bubble point (see 4.7.2.1.1.1).

* 4.7.2.1.2 Quality conformance bubble point - The filter element, containing no fluid, shall be installed in a setup similar to Figure 3. The fluid level shall be maintained at approximately 1/2 inch above the top of the filter element. The air pressure shall be preset to 0.1 inch of water less than the minimum initial bubble point. The filter element shall be rotated 360 degrees about its longitudinal axis and the entire filter area scanned for the appearance of any bubbles. There shall be no bubbles emerging from the filter. The fluid used shall be Proprietary Solvent #3, or equivalent, at 70° ± 5° F filtered through 0.45 micron membrane Millipore filter, or equivalent. Since the minimum bubble point value will differ for various filtration media, the value shall be obtained from the qualification approval letter for the particular filter element under test.

* 4.7.2.2 Filter element flush - The test fluid in the Figure 1 system shall be precleaned in accordance with paragraph 4.6.1.1. The filter element shall be installed in Figure 1 system and flushed at rated flow for 1 hour. The cleanup filter shall not be bypassed while flushing.

* 4.7.2.3 Cold start - The filter element shall be installed in a housing filled with oil and subjected to a temperature of -65° ± 5° F for four hours in a setup similar to Figure 6. The element shall then be subjected to 10 flow cycles at a differential pressure as specified in the applicable specification sheet, across the element with fluid held at -65 ± 5° F or lower. The relief valve (where applicable) shall be blocked. Each flow cycle be 15 ± 1 seconds in duration. A flow cycle-pressure time trace shall be prepared and included in the Qualification Test Report. There shall be no evidence of filter media damage for each element tested, as evidenced by satisfactory completion of subsequent tests listed in Table I.

* 4.7.2.3.1 For filter element No. 4 during the first and tenth cycle of the above test, 500 ml of test fluid shall be drawn down stream of the test filter. Prior to drawing samples a volume of fluid equal to the static fluid volume in the sampling line, fittings and valve shall be drawn and discarded. The fluid shall be analyzed in accordance with ARP 785 and paragraph 4.7.2.8.3.4. The weight of contaminant collected for each sample shall be multiplied by four and shall not exceed the migration analysis value listed in Table 1 of the applicable specification sheet.

4.7.2.4 Degree of filtration (filter element efficiency) - The degree of filtration for filter elements shall be determined by the test specified herein. It is of primary importance that the hydraulic fluid and air used in the degree of filtration test be clean and filtered prior to test. Figure 4 shows a degree of filtration test setup with a cleanup device attached.

4.7.2.4.1 System add and blank values - The test specified in 4.7.2.4.2, with the filter element removed and a free-flow dummy element installed, shall be repeated four times for four separate contaminant-add values (A in the 4.7.2.4.2 formula). Hydraulic fluid cleaned to a level that conforms with 4.6.1.1 shall be used for each test. The contaminant collected shall be the add value and shall be used in the calculation of degree of filtration. It shall be the average of these four runs. None of the four add values shall be less than 95 percent by weight of the contaminant introduced. To insure cleanliness of the system and the filter assembly, a system blank value shall be obtained by repeating 4.7.2.4.2 (a) thru (c) with the filter element installed and no contaminant added. This blank value shall be the value C in the following efficiency formula and shall be less than 0.0007 gram.

4.7.2.4.2 Test procedure:

(a) A setup shall be made as shown on Figure 4 without installing the filter element in the test housing.

(b) Flush 2,000 ml. of prefiltered hydraulic fluid through the contaminant mixing chamber and the filter housings, and discard. This operation shall be repeated.

(c) The hydraulic fluid of the second flush in (b) shall be checked in accordance with 4.6.1.1.

(d) Add 2,000 ml. of previously filtered hydraulic fluid through plug valve A. The element shall be installed in the filter housing.

(e) Valve B shall be closed.

(f) A 5-ml. slurry containing contaminant, in accordance with Table I of the applicable specification sheet, shall be added to the hydraulic fluid through a small funnel inserted in the plug valve A. The contaminant shall be APM F-9 beads, or AC dust and APM F-9 beads as specified.

(g) The contaminant shall be distributed uniformly by churning the hydraulic fluid with an agitator for 3 minutes minimum.

(h) Plug valve A shall be closed and the glass chamber containing the hydraulic fluid and contaminant shall be pressurized using the air regulator. The air regulator is used to maintain rated flow.

(i) Valve B shall be opened and air pressure shall force the hydraulic fluid containing the contaminant through the sample filter assembly. This filtrate shall be collected in a clean 4,000-ml. beaker. Using a suitable wash bottle, 750 ml. of petroleum ether (boiling point (b.p.) 90° to 130° F) shall then be washed through the contaminant mixing chamber and test filter assembly. The wash fluid shall be collected in the same 4,000-ml. beaker.

(j) A membrane filter 47-mm. diameter disk, absolute 0.8-micron type AA Millipore, or equivalent, shall be washed with 200 ml. of prefiltered petroleum ether and dried to constant weight at 125° F. The weight shall be accurate to 0.1 milligram (mg.). The disk shall be heated at 125° F for 30 minutes and then cooled 30 minutes in a desiccator.

(k) The weighed filter membrane shall be assembled into the filter holder assembly (see Figure 5) and fitted to a 4,000-ml. vacuum flask connected to a suitable vacuum.

(l) All hydraulic fluid passed through the test filter is filtered through the membrane disk. The 4,000-ml. beaker shall be washed with 500 ml. of prefiltered naphtha and 500 ml. of prefiltered petroleum ether (b.p. 95° to 130°F) and fluid from the washer beaker shall be passed through the membrane. The filter funnel shall also be washed down with 100 ml. of prefiltered naphtha and 100 ml. of prefiltered petroleum ether.

(m) Maintaining vacuum, the top half of the filter funnel assembly shall be removed. The membrane filter shall now be exposed for further washing.

(n) With a wash bottle of prefiltered petroleum ether (b.p. 95° to 130°F), the rim of the membrane filter shall be gently washed to remove traces of hydraulic fluid, being careful not to disturb the cake. Vacuum shall be maintained during this operation.

(o) The vacuum shall be shut off and the membrane filter removed. It shall be dried to a constant weight at 125°F and weighed to 0.1 of a mg.

The difference between the membrane filter weights before and after the above procedure is the weight of contaminant passing through the test filter, B in the following formula:

$$\text{Filter element efficiency} = \frac{A - (B - C)}{A} \times 100$$

Where:

A = (add value) = Amount of test contaminant passed through system when there is no filter element in the filter housing.

B = (Contaminant value) = Amount of test contaminant passed through the test filter assembly (element installed).

C = (blank value) = Amount of contaminant attributed to the test system and test filter assembly when no test contaminant has been added.

The filter element efficiency shall be as specified in the applicable specification sheet.

4.7.2.5 Maximum particle passed - The maximum particle passed shall be determined by the following method:

(a) A degree of filtration (filter element efficiency) test shall be conducted in accordance with the procedure specified in (a), (b), (c), (d), and (e) of 4.7.2.4.2.

* (b) A 5-ml. slurry containing contaminant,. in accordance with Table I of the applicable specification sheet, shall be added to the hydraulic fluid through a small funnel inserted in the plug valve A.

(c) Continue with degree of filtration test in accordance with procedure specified in (g), (h), and (i) of 4.7.2.4.2.

(d) All hydraulic fluid passed through the test filter element shall be filtered through a 0.8-micron membrane filter disk AA Millipore, or equivalent (see Figure 5). The 4,000-ml. beaker shall be washed with 500 ml. of prefiltered naphtha and 500 ml. of prefiltered petroleum ether (b.p. 95° to 130°F) and hydraulic fluid from the washed beaker shall be passed through the membrane filter disk. The filter funnel shall also be washed down with 100 ml. of prefiltered naphtha and 100 ml. of prefiltered petroleum ether.

(e) The entire disk shall be scanned. The largest bead or Carbonyl Iron E particle, as applicable, shall be no greater than the value specified in the applicable specification sheet. This membrane shall be retained for possible scanning in accordance with 4.7.2.8.3.4.

NOTE: In order to obtain an absolute test result, the test setup downstream of the filter element and all glassware should not have been previously used with glass beads or Carbonyl Iron E.

* 4.7.2.6 Pressure buildup and collapse -

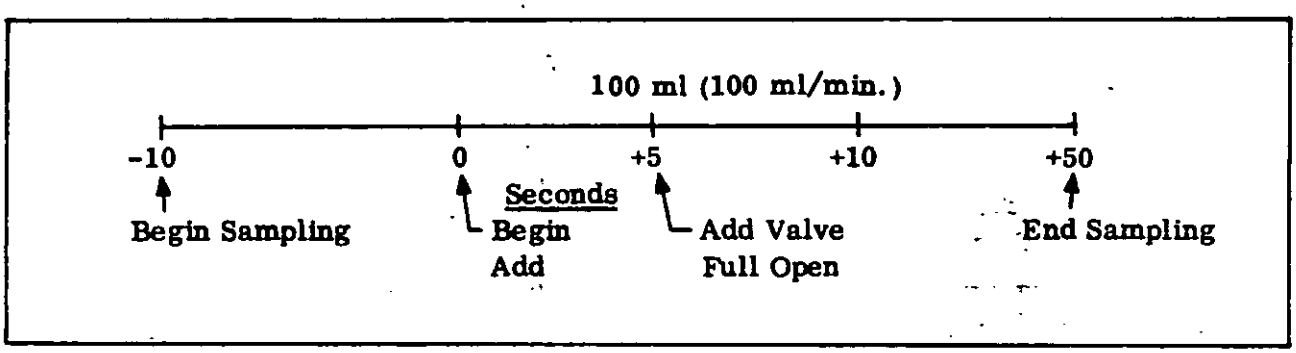
* 4.7.2.6.1 Pressure buildup and collapse for all 5 micron absolute elements

(a) The hydraulic test fluid used in the system shown on Figure 1 shall be precleaned and checked for cleanliness in accordance with 4.6.1.1. The fluid viscosity shall be a minimum of 13 centistokes for this test.

(b) The filter element under test shall be installed in the housing.

* (c) The pump shall be started, valves A and B opened, and rated flow attained. The cleanup filter shall be by-passed during the entire test. The pressure drop across the filter element shall not exceed the value specified in the applicable specification sheet.

* (d) Standardized fine air cleaner (A-C) test dust, in slurry shall be added through the dust valve H, in the contaminant-add increments applicable to the size of filter element, at 4-minute intervals as specified in Table I of the applicable specification sheet. Ten seconds prior to the add interval, begin sampling 100 ml fluid downstream of the test housing. Sampling shall continue on the following time base:



Pass the 100 ml sample through a 0.45 micron Millipore membrane filter or equivalent or an automatic particle counter. If a membrane filter is used wash with petroleum ether, dry, identify, and store in a petri dish. Sample fluid with clean element and at every add until a differential pressure of 150 psid is obtained. Count all particles in the following size ranges, in microns: 5-15, 15-25, 25-50, 50-100, and greater than 100. Tabulate to show the count in each size range at each pressure differential. Identify the tabulation with the element part number and serial number. The particle counts shall not exceed NAS 1638, class 4. Two minutes after each test dust addition, pressure differential flow and temperature shall be recorded. The differential pressure across the filter element shall not exceed the value specified in Table I of the applicable specification sheet when the minimum total AC dust shown in Table I is added. The pump shall not be stopped during the test. Additional dust shall be added until the minimum collapse pressure specified in the applicable specification sheet (element collapse), is obtained across the element at rated flow. The minimum collapse pressure shall be imposed for two successive times and held for 2 minutes each time. There shall be no sign of structural failure following this test as indicated by a visual examination and bubble point test (4.7.2.1.1). For elements loaded to 4500 psid, the bubble point test shall be conducted after loading the element to 3000 psid.

* 4.7.2.6.2 Pressure buildup and collapse for 15 micron absolute elements -

4.7.2.6.2.1 Filter element pressure drop (cleanable elements only) -

4.7.2.6.2.1.1 Method of test - To insure filter element cleanability, the filter element shall be subjected to a pressure drop test in a fixture similar to that being used by Naval fleet activities in order to establish a reference element pressure drop. A flow test setup shall be constructed in general accordance with the flow test schematic shown in Drawing 63A109. The test fixture, probe, and plumbing schematic shall be in accordance with the subassembly Drawing 63A109-D-78, 63A109-C-139, and 63A109-C-91. A flow test shall be performed in accordance with 63A109-C-91. The flow test shall be performed using 1,1,1-trichlorethane as a test fluid as the following flow rates;

Filter element size (M8815/3)	Flow (percent of full scale)
-8	20
-10	30
-12	50
-16	50

4.7.2.6.2.1.2 New element pressure drop value - The value obtained in 4.6.2.7.2.1.1 shall be used to establish the new filter element pressure drop for quality conformance testing.

4.7.2.6.2.2 Test method -

(a) The hydraulic test fluid used in the system shown on Figure 1 shall be precleaned as specified in 4.6.1.1. The fluid viscosity shall be a minimum of 13 centistokes for this test. The fluid shall be checked for cleanliness in accordance with 4.6.1.1. The cleanup filter specified in 4.6.1.2 shall be bypassed when the test is begun and will remain bypassed until completion of the tests.

(b) The filter element under test shall be installed in the housing.

* (c) The pump shall be started, valves A and B opened, and rated flow attained. The pressure drop across the filter element shall not exceed the value specified in the applicable specification sheet.

* (d) Standardized fine air cleaner (A-C) test dust, in slurry shall be added through the dust valve H, in the contaminant-add increments applicable to the size of filter element, at 4-minute intervals as specified in Table I of the applicable specification sheet. Two minutes after each test dust

addition, pressure differential flow and temperature shall be recorded. The differential pressure across the filter element shall not exceed the value specified in Table I of the applicable specification sheet when the minimum total AC dust shown in Table I is added. The pump shall not be stopped during the test. For MIL-F-8815/3 elements, additional dust shall be added until the differential pressure of 3,000 psi is obtained across the element at rated flow. The dirt capacity to 3,000 psi shall be noted and recorded. Rated flow shall be obtained at 3,000 psi.

(e) Cleanable MIL-F-8815/3 elements shall be loaded 10 times to 3,000 psi and cleaned 10 times. The filter element shall be subjected to the pressure drop test specified in 4.7.2.6.2.1. After final cleaning, the filter shall be subjected to and shall meet all requirements specified in 4.7.2.6.2.2 (a), (b), (c) and (d). Elements shall be cleaned in accordance with procedure specified in 4.7.2.6.2.3.

(f) Circulate fluid at 20% of rated flow (minimum), add additional quantities of AC dust to the system until the minimum collapse pressure specified in the applicable specification sheet is obtained. The minimum collapse pressure shall be imposed for two successive times and held for 2 minutes each time.

4.7.2.6.2.2.1 Maximum pressure drop after cleaning value - The value obtained in 4.7.2.6.2.2 (e) shall be indicated on each cleanable filter element in accordance with 3.8.2 (the value shall be subject to the approval of the activity responsible for qualification).

4.7.2.6.2.3 Cleaning procedures - To insure cleanability and material compatability with the cleaning solvents, two elements shall be subjected to the tests specified herein. One filter element shall be cleaned in accordance with cleaning procedure I and the second element in accordance with cleaning procedure II.

4.7.2.6.2.3.1 Cleaning procedure I - The filter element shall be cleaned in an ultrasonic cleaner having sufficient power to clean a qualified filter element using the following procedure: (A typical cleaner is one conforming to Drawing 63A109).

(a) Mount the filter element on a suitable rack.

(b) Degrease in 1,1,1-trichlorethane.

(c) Ultrasonically clean the filter element is a solution of Turco Surgex, or equivalent, for a period of 30 minutes. The filter element shall be rotated 90 degrees every 5 minutes to facilitate complete cleaning.

(d) Rinse the filter element in 1,1,1-trichlorethane.

(e) Ultrasonically clean the filter element in 1,1,1-trichlorethane for a period of 30 minutes. The trichlorethane shall be filtered through a filter element having the filtration characteristics conforming to MIL-F-81836(AS). The filter element shall be rotated 90 degrees every 5 minutes during the cleaning period to facilitate complete cleaning.

4.7.2.6.2.3.2 Cleaning procedure II - Filter elements shall be cleaned in accordance with AFTM T.O. 9H3-1-1, except that ultrasonic cleaning equipment having equivalent power may be substituted, provided that cleaning solutions and cleaning times are the same.

4.7.2.7 Flow fatigue - Filter elements shall be installed in nonbypass type filter housings and shall be subjected to pressure-flow cycles with hydraulic fluid at minimum of 30% of rated flow and at 275° ± 5°F. A cycle shall consist of increasing the differential pressure across the filter element from zero to the maximum specified and back to zero by first increasing, then decreasing, the flow through the test filter element, which has been loaded with A-C fine test dust, or equivalent. Peak pressure shall be reached within 25 percent of the cycle and held for at least 50 percent of each cycle.

4.7.2.7.1 The cycling rate and the number of cycles at each differential pressure shall be as specified in the applicable specification sheet. There shall be no evidence of damage as indicated by the bubble test as a result of this test.

4.7.2.8. Media and abrasion migration -

4.7.2.8.1 Preparation of filter assembly for blank analysis - Aluminum unions of the proper size conforming to AN815, with suitable seals and modified to add lockwire holes, shall be installed in the inlet and outlet ports of the filter housing and lockwired in place. The unions shall not be removed during the media migration test.

4.7.2.8.2 Blank analysis of filter housing with dummy element without vibration -

4.7.2.8.2.1 The housing, with a dummy element, shall be installed in the Figure 4 system and flushed with prefiltered hydraulic test fluid (see 4.6.1.1) for 10 minutes at rated flow. The following test shall be conducted:

(a) Plug valves A and B shall be closed and the glass chamber containing 2000 ml of hydraulic fluid shall be pressurized using the air regulator. The air regulator is used to maintain rated flow.

(b) Valve B shall be opened and air pressure shall force the hydraulic fluid through the sample filter assembly. This filtrate shall be collected in a clean 4,000-ml. beaker. Using a suitable wash bottle, 750 ml. of petroleum ether (boiling point (b.p.) 95° to 130°F) shall then be washed through the glass chamber and test filter assembly. The wash fluid shall be collected in the same 4,000-ml. beaker.

(c) A membrane ffilter 47-mm. diameter disk, absolute 0.8-micron type AA Millipore, or equivalent, shall be washed with 200 ml. of prefiltered petroleum ether and dried to constant weight at 125°F. The weight shall be accurate to 0.1 milligram (mg.). The disk shall be heated at 125°F for 30 minutes and then cooled 30 minutes in a desiccator.

(d) The weighed filter membrane shall be assembled into the filter holder assembly (see Figure 5) and fitted to a 4,000-ml. vacuum flask connected to a suitable vacuum.

(e) All hydraulic fluid passed through the test filter is filtered through the membrane disk. The 4,000-ml. beaker shall be washed with 500 ml. of prefiltered petroleum ether (b.p. 95° to 130°F) and fluid from the washed beaker shall be passed through the membrane. The filter funnel shall also be washed down with 100 ml. of prefiltered naptha and 100 ml. of prefiltered petroleum ether.

(f) Maintaining vacuum, the top half of the filter funnel assembly shall be removed. The membrane filter shall now be exposed for further washing.

(g) With a wash bottle of prefiltered petroleum ether (b.p. 95° to 130°F), the rim of membrane filter shall be gently washed to remove traces of hydraulic fluid, being careful not to disturb the cake. Vacuum shall be maintained during this operation.

(h) The vacuum shall be shut off and the membrane filter removed. It shall be dried to a constant weight at 125°F and weighed to 0.1 of a mg. The difference between the membrane filter weights before and after the above procedure is the blank value C in the abrasion migration formula (4.7.2.8.3.3) and shall not exceed 0.0007 grams.

4.7.2.8.3 Analysis of the filter assembly -

4.7.2.8.3.1 Preparation of filter assembly for vibration analysis - The filter assembly, with inlet and outlet unions lockwired in place, shall be filled to the top of the element with prefiltered hydraulic test fluid (see 4.6.1.1). The inlet and outlet unions shall be capped with precleaned two-piece aluminum caps (modified to add lockwire holes) conforming to AN929. The test filter assembly shall be mounted in the normal position (bowl at bottom) on a suitable fixture. The bowl shall be completely removed from the head and reinstalled in the head, assuring that only a minimum of fluid be spilled from the bowl. The filter assembly shall be soaked at 265° ± 10°F for 72 hours and then cooled to room temperature (70° to 90°F). The cap of the inlet port shall then be removed while the unit is in a horizontal position with the outlet port facing downward. Prefiltered hydraulic fluid (see 4.6.1.1) shall then be added to completely fill the unit. Port caps and bowl shall then be lockwired to the filter head.

4.7.2.8.3.2 Media and abrasion migration - A sinusoidal vibration test shall be conducted on the filter assembly at room temperature in each of the filter assemblies three mutually perpendicular axes. One of these axes shall be that which is parallel to the exit flow path of the filter element.

The filter assembly shall be mounted on a resonance-free fixture for test. The vibration input accelerometer shall be mounted on the fixture close to the mounting point of the filter assembly to the fixture. A second accelerometer shall be mounted directly on the filter assembly for monitoring resonant frequencies.

The rate of change of frequency shall be logarithmic.

Vibration Tolerances

Amplitude	± 10%
Frequency	± 2%
Acceleration	± 10%

The following tests shall be conducted: (a) Resonance search-resonant frequencies of the filter assembly shall be determined by varying the frequency of applied vibration slowly through the range specified in Table III, Part 1, at reduced levels but with sufficient amplitude to excite them. This shall be repeated for each of the three axes.

(b) Resonance dwell - the filter assembly shall be vibrated along each axis at the four most severe resonant frequencies (determined in the resonance search) for 30 minutes at each resonance. The vibration levels and test times shall be per Table III, Part 1.

(c) Cycling test - the filter assembly shall be vibrated along each axis in accordance with the test levels, frequency range and times from Table III, Parts 1 and 2. The frequency of applied vibration shall be swept over the frequency range of 5 to 2000 to 5 Hz logarithmically. The time to sweep from 5 to 2000 to 5 Hz shall be approximately 20 minutes. If a change in the resonant frequency occurs during the test, its time of occurence shall be recorded and immediately the frequency shall be adjusted to maintain the peak resonance condition. The final resonant frequency shall be recorded.

TABLE III. Test Procedure and Time Schedule

	Vibration Level					
Part 1	0.1 inch double amplitude 1.0 g 0.036 inch double amplitude 10.0 g					Frequency Band, Hz 5 to 14 14 to 23 23 to 74 74 to 2000
Part 2	0.2 inch double amplitude 1.0 g 0.06 inch double amplitude 20.0 g					5 to 10 10 to 18 18 to 81 81 to 2000
	Vibration Time Schedule - (Time Per One Axis)					
Part 1	Number of Resonances	0	1	2	3	4
	Total Vibration Time at each Resonance	0	½ hr	1 hr	1½ hr	2 hr
	Cycling Time	2 hr	1½ hr	1 hr	½ hr	0
Part 2	30 minutes cycling per axis - no resonance dwell					

4.7.2.8.3.3 The caps shall be removed from the port unions and the test specified in 4.7.2.8.2.1 shall be performed on the filter assembly. The value obtained represents the analysis value A in the following migration formula:

$$X = A - C$$

Where A = Analysis value specified in 4.7.2.8.3.3
C = Blank value of housing without vibration specified in 4.7.2.8.2.1.
X = Migration analysis value.

The migration analysis value shall not exceed the values listed in Table I of the applicable specification sheet.

4.7.2.8.3.4 After completion of the weights analysis, the analysis membrane from 4.7.2.8.3.3 shall be examined for evidence of filter media migration using the procedure specified in ARP 598. There shall be no media migration identifiable as coming from the filter element medium. The membrane filter used for this test shall be of contrasting color to the filter element medium. A microscope of adequate magnification shall be used to accurately analyze the material collected on the membrane. In the event the abrasion material masks possible filter media migration, the membrane retained from the maximum particle passed test (4.7.2.5) shall be scanned for evidence of filter media migration. There shall be no migration identifiable as coming from the filter media.

* 4.7.2.9 Relief valve operation (M8815/13 element only)

* 4.7.2.9.1 Relief valve operation qualification - Filter elements having integral relief valves, see applicable specification sheet, shall be subjected to the following tests. The filter element media shall be blocked and the filter element installed in a suitable housing. By means of a power-driven pump, pressure shall be applied to the inlet port of the filter housing, beginning with a pressure of 20 psi and increasing in increments of 10 psi or less until cracking pressure of the relief valve in the filter element being tested is reached. At each increment, the pressure shall be maintained constant for 5 minutes. At each pressure increment, time shall not be considered "in" or leakage noted until the beginning of the third minute. The leakage rate during the last 3 minutes of each pressure increment shall be noted. The pressure at which the leakage rate through the relief valve amounts to 8 cubic centimeters (cc) (approximately 160 drops) per minute shall be considered as cracking pressure. Cracking pressure shall occur at 50 $\pm$ 5 psi. Leakage up to 40 psi shall not exceed 4 cc. (approximately 80 drops) per minute. Pressure shall be increased until rated flow through the relief valve is obtained. Rated flow shall occur at a pressure differential between inlet and outlet ports not exceeding 80 psi.

The pressure shall be reduced in 10 psi decrements as above until leakage through the relief valve does not exceed the rate of 10 drops per minute. The resulting pressure shall be considered the relief valve reseating pressure and shall occur at a pressure of 30 psi or above.

* 4.7.2.9.2 Relief valve test (quality conformance) - The filter element relief valve shall be installed in a suitable test block. By means of a power driven pump, pressure shall be applied to the inlet port of the test block, and increased to 40 psi. After 3 minutes maximum the leakage shall not exceed 4 cc/min. The pressure shall then be raised to 44.5 psi. After 3 minutes maximum, the leakage shall not exceed 8 cc/min. The pressure shall then be raised to 55.5 psi. The leakage measured shall exceed 8 cc/min. Increase the flow to 1.5 gpm. The maximum pressure drop shall not exceed 80 psi. Reduce the pressure to 30.0 psi and the leakage measured shall not exceed 4 cc/min. after 3 minutes maximum.

4.8 Preservation, packaging, and marking - Preparation for delivery shall be examined for conformance to section 5.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging - Preservation and packaging shall be in accordance with MIL-STD-794, level A only.

5.1.1 Cleaning - Prior to preservation, the filter assemblies or elements shall be cleaned ultrasonically (or equivalent method) until free from all metal chips, grit, dirt, and other foreign matter. The cleaning method utilized shall not have deleterious effects on any material (e.g., metals, plastics, elastomers, etc.). Care shall be taken after cleaning to insure that neither the assembly or element is contaminated prior to or during preservation or packaging.

* 5.1.2 Preservation (assemblies) - The filter assembly shall be flushed and filled 80 to 90 percent with hydraulic fluid conforming to MIL-H-6083, prefiltered through a filter assembly conforming to MIL-F-81836(AS), or a filter with equivalent efficiency and sealed with metal closures conforming to MIL-C-5501. The filter assembly shall then be placed within a heat-sealed bag confroming to MIL-B-117, Type I, Class E.

5.1.3 Preservation (elements) - Each element shall be allowed to air dry after cleaning. Air drying shall be accomplished in an atmospherically controlled clean room or laminar flow bench. When dry, the element shall then be placed within a heat-sealed bag conforming to MIL-B-117, Type I, Class E.

5.1.4 Packaging - Each filter assembly or element in its sealed bag shall be cushioned and snugly packaged within a carton or box conforming to PPP-B-566 or PPP-B-676.

5.2 Packing - Packing shall be in accordance with MIL-STD-794, level A, B, or C, as specified in the contract or order (see 6.2). Exterior containers shall contain identical quantities and, as far as practical, shall have the minimum cube and tare consistent with the protection required.

* 5.2.1 Level A - Assemblies or elements packaged as in 5.1.4, shall be packed in snug-fitting fiberboard containers conforming to PPP-B-636, weather resistant. Containers shall be closed and sealed as specified in the appendix of PPP-B-636.

* 5.2.2 Level B - Assemblies or elements packaged as in 5.1.4, shall be packed in snug-fitting fiberboard containers conforming to PPP-B-636, domestic. Containers shall be closed and sealed as specified in the appendix of PPP-B-636.

5.3 Marking of shipments - Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129 and, in addition, shall include the following:

M8815/ (insert slash number of specification sheet)
Month and year of manufacture
Style and size

6. NOTES

6.1 Intended use - The filter assemblies and filter elements covered by this specification are intended for use in aircraft and missile hydraulic systems covered by MIL-H-5440 and MIL-H-25475, and operating with hydraulic fluid conforming to MIL-H-5606 or MIL-H-83282 at nominal operating pressures of 3,000 psi.

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

(a) Title, number, and date of this specification.

(b) Specification sheet part numbers. (See MIL-F-8815 Supplement 1).

(c) Type, class, micron rating and style (see 1.2).

(d) Applicable levels of preservation, packaging, and packing (see section 5).

* 6.2.1 Contract data requirements - Items of deliverable data required by this specification are cited in the following paragraphs:

Paragraph	Data Requirement	Applicable DID
4.5.4	Report of failure of sampling test	DI-R-5299A

Such data will be delivered as described on approved (numbered) DID's (Data Item Description/DD Form 1664) when specified on DD Form 1423 (Contract Data Requirements List) and incorporated into the applicable contract.

6.3 Qualification - 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 Naval Air Systems Command, Attn: AIR-530312, Department of the Navy, Washington, D.C. 20360; however, information pertaining to qualification of products may be obtained from the Commanding Officer, Naval Air Development Center, (Code 3021), Warminster, Pennsylvania 18974.

* 6.4 Changes from previous issue - The margin of this specification is marked with an asterisk to indicate where changes (additions, modications, corrections, deletions) from the previous issue MIL-F-8815C were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - AV
Navy - AS
Air Force - 11
Reviewer activities:
Army - MI
Air Force - 71

Preparing activity: Navy - AS
(Project No. 1650-0326)

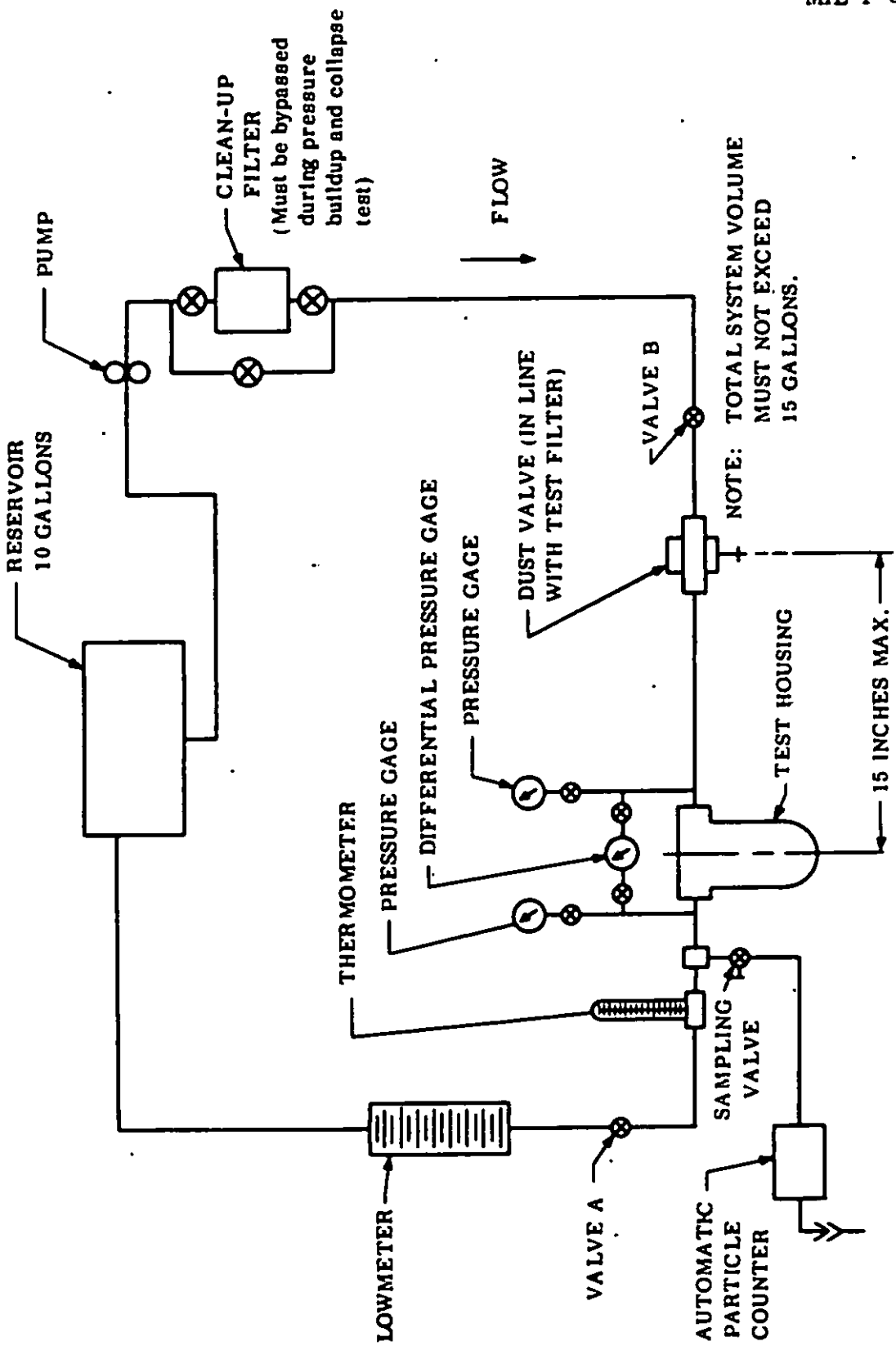
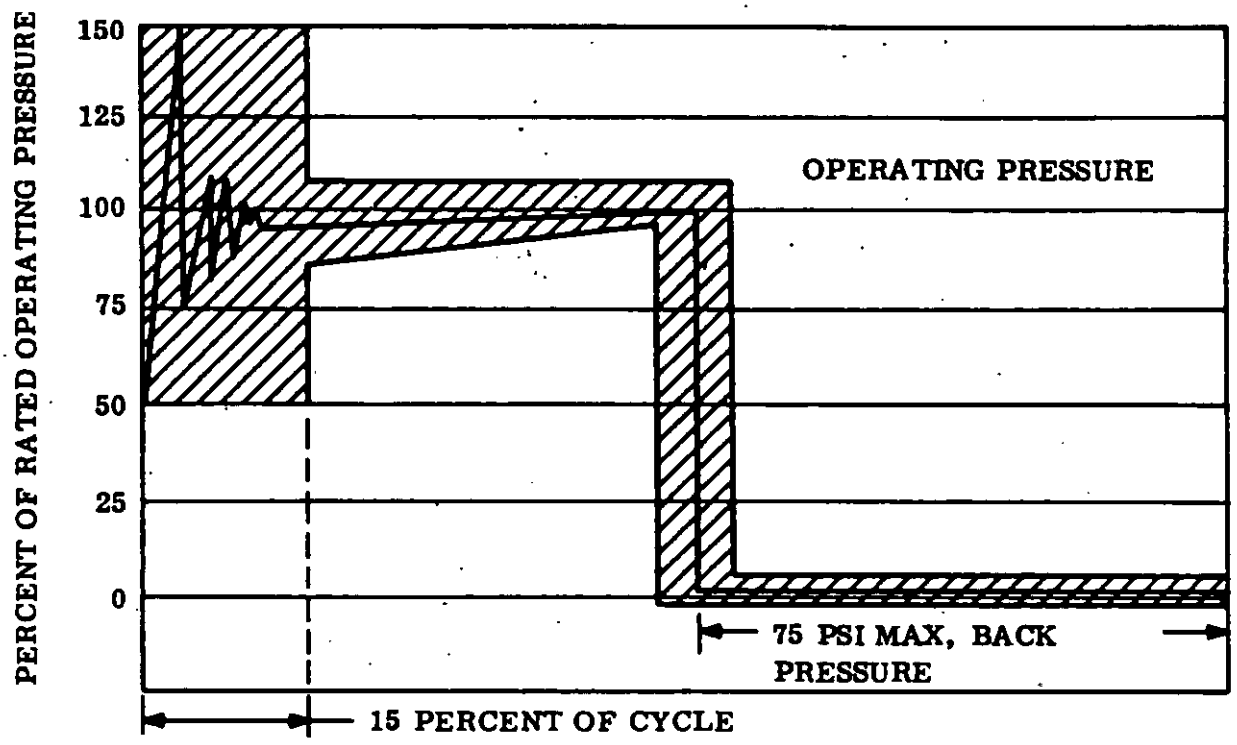


FIGURE 1. Typical setup for determining pressure buildup and collapse pressure characteristics



THE CURVE SHOWN ABOVE IS THE APPROXIMATE PRESSURE-TIME CYCLE DETERMINED TO BE OF PROPER SEVERITY FOR IMPULSE TESTING. ALTHOUGH IT IS MANDATORY ONLY THAT PRESSURE PEAK RISES TO 150 PERCENT OF THE OPERATING PRESSURE AT SOME POINT PRIOR TO LEVELING OFF AT RATED PRESSURE, IT IS CONSIDERED HIGHLY DESIRABLE THAT THE PRESSURE-TIME CURVE BE CONFINED TO THE SHADED AREA INDICATED. ONE VERY DESIRABLE BENEFIT TO BE GAINED IN THIS MANNER IS THAT RESULTS OF TESTS PERFORMED ON DIFFERENT TEST MACHINES WILL BE MORE NEARLY COMPARABLE.

INITIAL RATE OF RISE PRESSURE APPLICATION TO BE 200,000-300,000 PSI PER SECOND.

FIGURE 2. Impulse curve

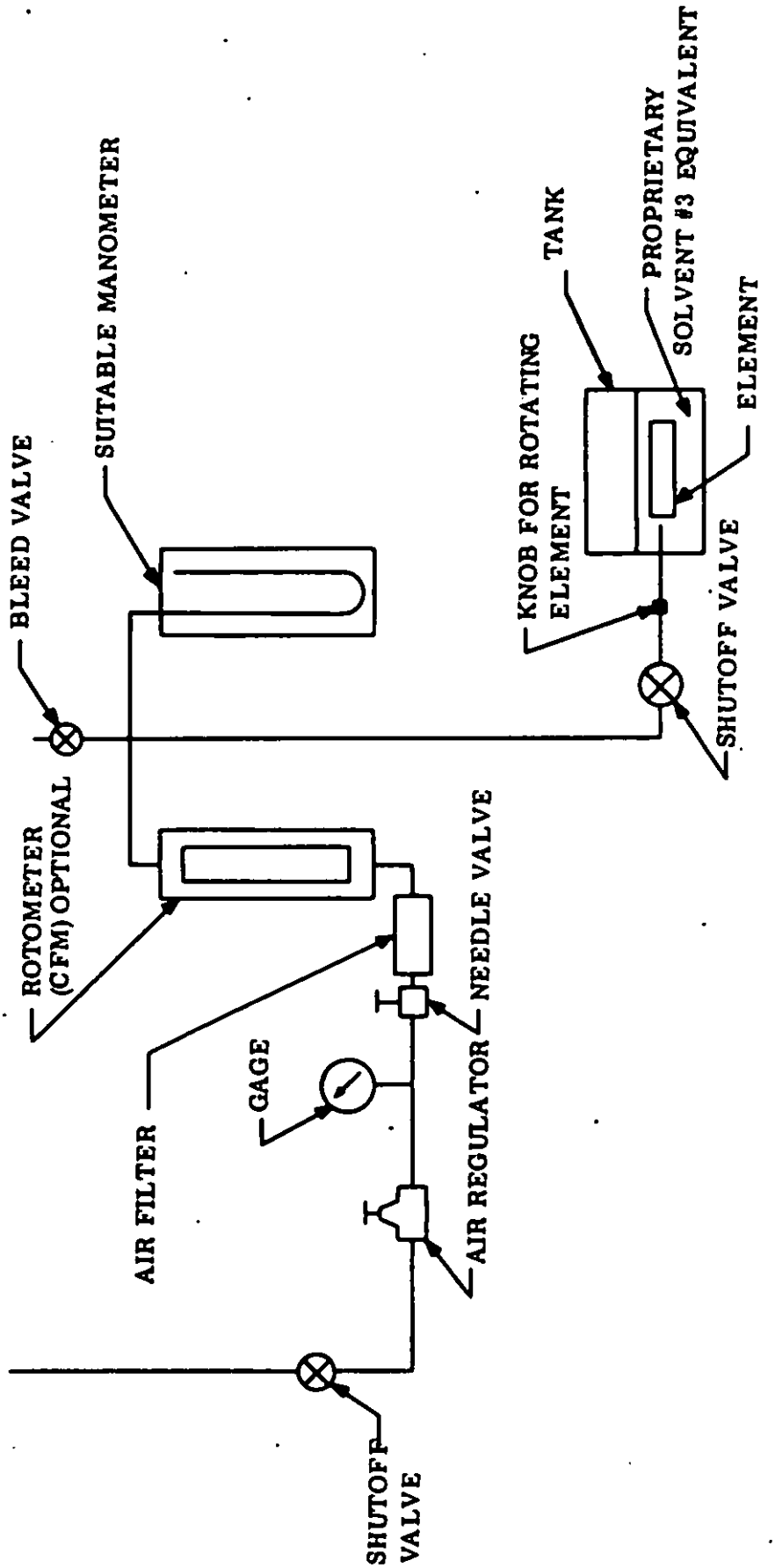


FIGURE 3 Typical schematic diagram for air bubble test

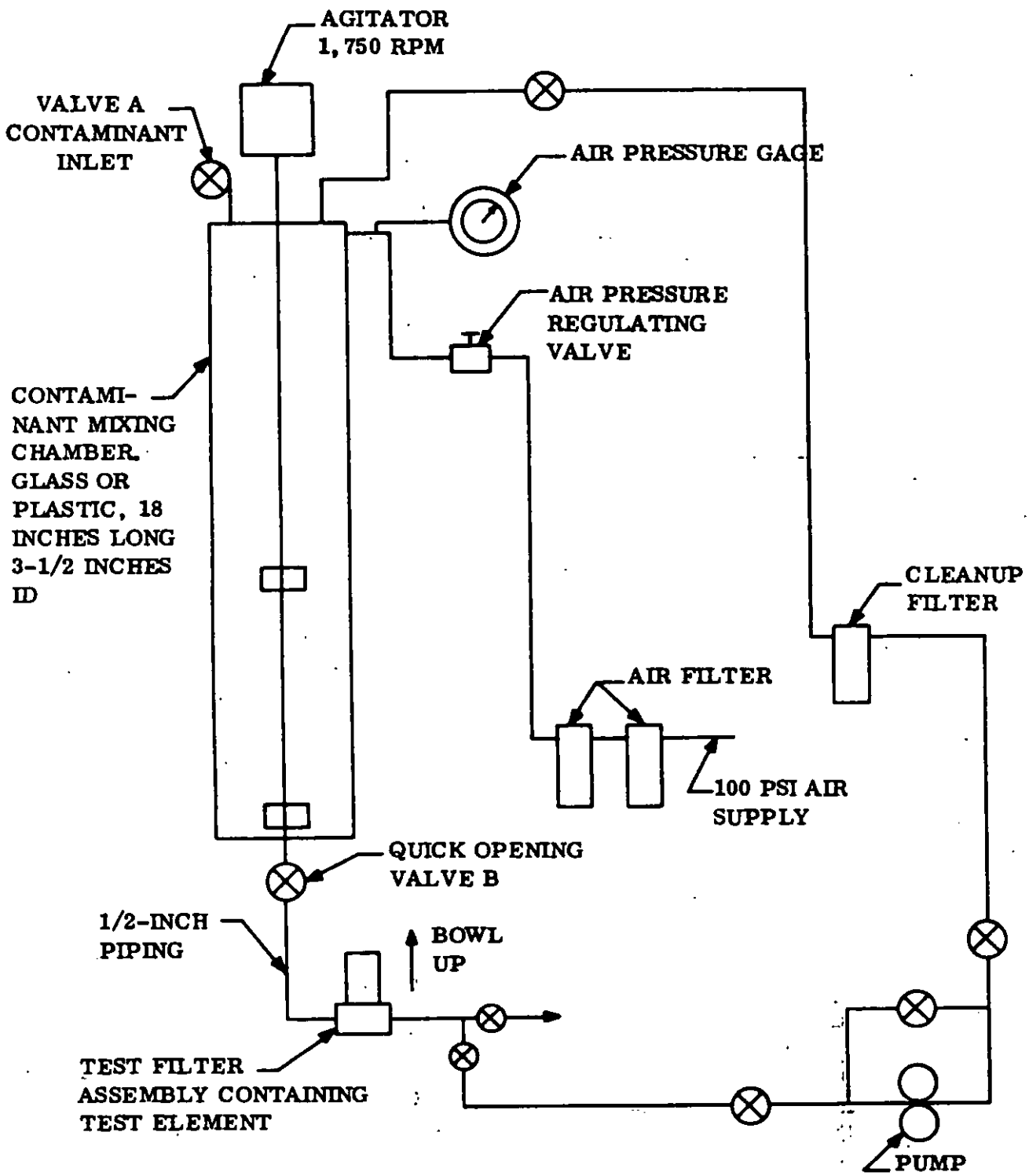


FIGURE 4. Typical apparatus for determining filtration efficiency of line-type element

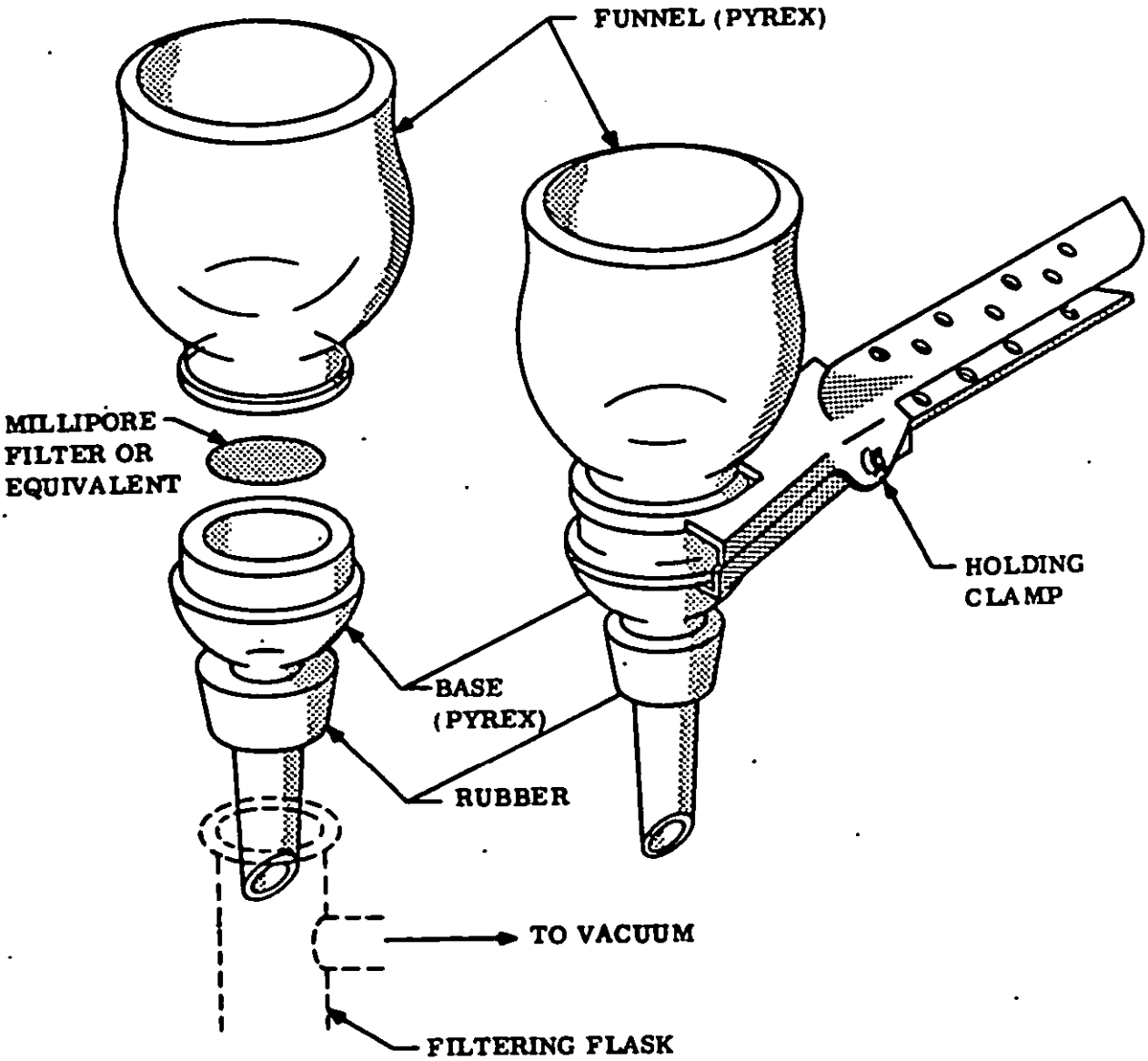
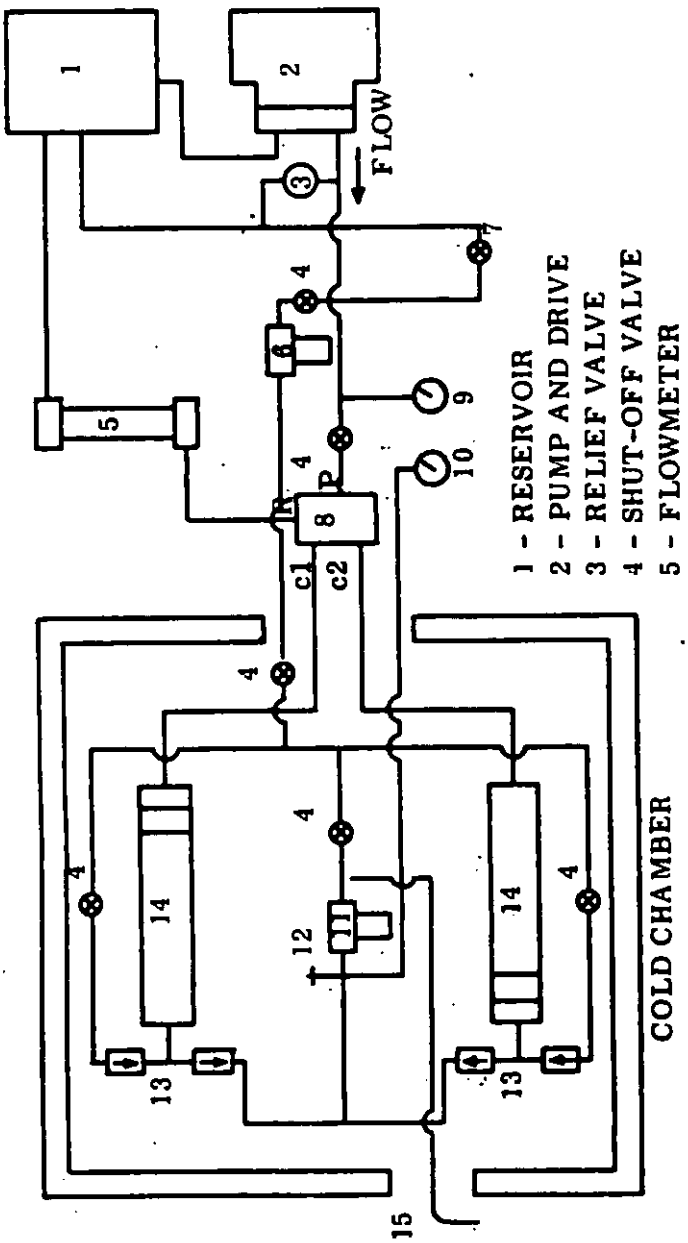


FIGURE 5. Diagram of effluent filtration setup.



1 - RESERVOIR
2 - PUMP AND DRIVE
3 - RELIEF VALVE
4 - SHUT-OFF VALVE
5 - FLOWMETER
6 - SYSTEM FILL FILTER
7 - BY-PASS VALVE
8 - FOUR WAY SELECTOR VALVE
9 - SYSTEM PRESSURE GAUGE
10 - TEST PRESSURE GAUGE
11 - TEST FILTER HOUSING
12 - THERMOCOUPLE
13 - CHECK VALVE
14 - TRANSFER CYLINDER
15 - SAMPLING LINE

FIGURE 6. Typical schematic diagram for cold start test

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 1426 PREVIOUS EDITION IS OBSOLETE.