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GEORGE C. MARSHALL SPACE FLIGHT CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROCEDURE

HYDRAULIC SYSTEM DETAILED PARTS, COMPONENTS, ASSEMBLIES, AND HYDRAULIC FLUIDS FOR SPACE VEHICLES, CLEANING, TESTING, AND HANDLING

This procedure has been approved by the George C. Marshall Space Flight Center (MSFC) and is available for use by MSFC and associated contractors.

1. PURPOSE

1.1 The purpose of this procedure is to establish standard criteria for cleaning, testing, and handling hydraulic system detailed parts, components, assemblies, and hydraulic fluids for use on space vehicles and related ground support equipment.

2. SCOPE

2.1 This procedure specifies requirements, materials, and equipment for cleaning, testing, and handling of hydraulic system detailed parts, components, assemblies, and hydraulic fluids for use in closed-loop,hydraulic systems on-board space vehicles and in supporting equipment. It also includes requirements for environmental control and protection of work areas and equipment, pretest inspection, and tagging of cleaned and packaged components.

3. REFERENCES

3.1 The following documents form a part of this procedure to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposals shall apply.

SPECIFICATIONS

Federal

O-A-51	Acetone, Reagent Grade.
O-A-88	Acid, Nitric; Technical Grade.
O-E-751	Ether, Petroleum, Technical Grade.
O-E-760	Ethyl, Alcohol, (Ethanol), Denatured Alcohol, and Proprietary Solvent.
O-H-795	Hydrofluoric Acid, Technical.
O-M-232	Methanol (Methyl Alcohol).
O-S-595	Sodium Dichromate, Technical Grade (Sodium Bichromate), Sodium Dichromate Dihydrate.
O-S-642	Sodium Phosphate, Tribasic, Technical Anahydrous, Dodecahydrate, and Monohydrate.
O-T-620	1,1,1-Trichloroethane, Technical, Inhibited (Methyl Chloroform).
O-T-634	Trichloroethylene, Technical.

Military

MIL-A-10428	Isopropyl Alcohol, Grade A.

George C. Marshall Space Flight Center

MSFC-SPEC-237	Solvent, Precision Cleaning Agent, Specification for.

STANDARDS

George C. Marshall Space Flight Center

MSFC-STD-105	Synthetic Rubber, Age Control of, Standard for.
MSFC-STD-246	Design and Operational Criteria of Controlled Environmental Areas, Standard for.

PUBLICATIONS

National Aeronautics and Space Administration

NPC 200-2	Quality Program Provisions for Space System Contractors.
NPC 200-3	Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with the application of this procedure should be obtained from the procuring activity or as directed by the contracting officer.)

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

Society of Automotive Engineers

ARP 598	Procedure for the Determination of Particulate Contamination of Hydraulic Fluids by the Particle Count Method.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York 17, New York.)

4. DEFINITIONS, ABBREVIATIONS, AND APPROVED SOURCES

4.1 Definitions. - For the purpose of this procedure, the following definitions shall apply.

4.1.1 Assembly. - An assembly is a major item that is installed in a hydraulic system. Typical examples are: hydraulic pumps, servo valves, servo actuators, hydraulic power packages, etc.

4.1.2 Component. - A component is defined as a group of assembled detailed parts. Components are not necessarily end items but are installed as parts of higher assemblies. Typical examples are: check valves, relief valves, quick disconnects, bleed valves, tubing, flexible hoses, etc.

4.1.3 Detailed part. - A detailed part is a single item used in conjunction with one or more single items to form a component or assembly. Typical examples are: fittings, filter housing, "O" rings, manifolds, servo valve bodies and spools, actuator cylinders, actuator bodies, actuator pistons, etc.

4.1.4 Fibers. - A fiber is defined as any particle measuring over 100 microns in length and having a length to width ratio of 10 to 1.0 or over.

4.1.5 Solvent. - The word solvent, as used in this procedure, shall refer to one of the following approved solvents.

(a) Trichloroethane

(b) Trichlorotrifluoroethane

(c) Petroleum ether

(d) Trichloroethylene

(e) Isopropyl alcohol

(f) Acetone

(g) Methyl alcohol

4.1.6 Drying or purging gases. - Gases used in drying components or assemblies shall not have a moisture content greater than 24 parts per million by volume.

4.2 Abbreviations. - For the purpose of this procedure, the following abbreviations shall apply:

(a)	Cycles per second	cps
(b)	Engineering order	EO
(c)	Fahrenheit	F
(d)	Gallons per minute	gpm
(e)	Gaseous nitrogen	GN_2
(f)	Ground support equipment	GSE
(g)	Millimeter	mm
(h)	Milliliter	ml
(i)	Pounds per square inch	psi
(j)	Pounds per square inch gage	psig
(k)	Revolutions per minute	rpm

4.3 Approved sources. - For the purpose of this procedure, the following are considered to be approved sources for the proprietary items specified herein:

(a) Mylar - DuPont, E. I. deNemours & Co., Inc.
Wilmington 98, Delaware

(b) Saran Wrap - Dow Chemical Corporation
Midland, Michigan

5. RESPONSIBILITIES

5.1 MSFC activities. - The implementation of this procedure shall be the responsibility of all activities of MSFC and associated contractors having the responsibility for the engineering design, manufacturing, or quality assurance provisions related to the development of space vehicles and associated equipment.

5.2 Quality control system. - The quality control system shall be in accordance with the National Aeronautics and Space Administration Quality Publications NPC 200-2 or NPC 200-3, as applicable.

6. PROCEDURES

6.1 Environmental control and protection. - Cleanliness is determined by the work area in which the cleaning, assembling, and testing are performed, the equipment used, and personnel who perform the above tasks. Contaminated work areas, contaminated equipment, and improper handling will contaminate a component and result in wasted effort; therefore, controlled environment is a necessity in obtaining the cleanliness level required.

6.1.1 Work areas. - Work areas that require controlled environment shall conform to the requirements of Standard MSFC-STD-246.

6.1.2 Equipment. - Hand tools and other equipment used in cleaning and testing processes shall be free from grease, lint, dust, and other foreign matter. Fluid containers and test equipment shall be tested regularly for excessive contamination.

6.1.3 Personnel instruction. - Personnel involved in cleaning, testing, and handling hydraulic system components and assemblies shall be instructed in precautionary measures necessary to avoid introduction of contamination.

6.2 Pretest inspection. - New, clean, filter elements, (as received), components, detailed parts, or assemblies removed from on-board space vehicle hydraulic systems shall be visually examined for breaks, cracks, excessive bends, dents, and excessively worn moving parts or threads. Each component, detailed part, or assembly shall be subjected to tests, as applicable, prior to cleaning. Defective components, detailed parts, or assemblies shall be rejected.

NOTE

O-rings and gaskets that have been removed from disassembled components shall be discarded. New precleaned O-rings and gaskets shall be used. Cure dates of O-rings and gaskets shall be within specified tolerances (see Standard MSFC-STD-105).

6.3 Production cleaning process. - The cleaning process and the type of equipment to be used shall be left to the discretion of the performing activity; however, approval of the process and the type of equipment to be used shall be obtained from the procuring activity. The use of the recommended procedures set forth herein will not guarantee

acceptance of the end product. The performing activity shall be required to submit a written plan to the procuring activity containing the following information as applicable to the program involved:

(a) Processing materials to be used. This shall include trade names, specifications, and chemical and physical properties.

(b) Processing equipment and cleaning procedures to be used.

(c) Quality assurance provisions to be utilized. This shall include in-process, qualification, and reliability checks to prevent built-in contamination or latent corrosion.

(d) Controlled environmental levels to be maintained for cleaning and assembly.

6.4 Tagging components and assemblies. - Upon completion of cleaning, packaging, and analysis, all components and assemblies shall be tagged with the following information:

(a) This item has been hydraulic cleaned in accordance with MSFC-PROC-166D, Vendor Procedure No. _____.

(b) Item name and part number.

(c) Date accepted.

(d) Inspector's seal, etc.

6.5 Particle size limitations. - Upon completion of assembly and testing, all components or assemblies (including their respective inner packaging materials) that contact the hydraulic oil shall contain no more than the number of particles specified in the applicable column of table I. Particle counts in excess of the applicable amounts shall be cause for recleaning.

6.6 Equipment. - The equipment required for particulate contamination analysis shall be as follows:

(a) Pyrex filter holder, consisting of:

(1) Fritted glass base and rubber stopper.

Table I. Particle size limitations (3)*

Item	Sample volume(1)	Particle size (microns) (5)				
		*** 0-10	10-25	25-50	50-100	Over 100
1. Filter element:						
(a) As released for space vehicle use	2 liters		50,000	1,250	100	10
(b) Blank analysis (filter test equipment)	2 liters		200	75	15	5
2. Hydraulic fluid:						
(a) High pressure onboard system	100 ml					
(b) Low pressure onboard system	100 ml					
(c) As released for space vehicle use	100 ml					
(d) As cleaned for issue (fluid used for filling test equipment)	100 ml		670	93	16	1
**(e) Water content						
3. Components (all components that will contact service media including containers, ground support equipment, etc.) (4) Detailed parts process qualification	100 ml/ sq ft		600(2)	100(2)	16(2)	2
4. Assemblies and systems (effluent oil) pumps, servo valves, hydraulic power packs, and servo actuators	100 ml		2,150	530	60	10

*See notes on following page.

**Water content of the hydraulic fluid shall not exceed 100 ppm.

***Particles under 10 microns are not counted. However, a concentration of particles under 10 microns in size sufficient to obscure any of the membrane grid lines shall be cause for rejection.

NOTES: (1) Solvent or hydraulic fluid depending on items involved.
(2) Number of particles allowed per square foot of critical surface, one square foot being the minimum considered. Small parts of simple configuration should be held to less.
(3) Uncorrected count - control count not subtracted from test count.
(4) All detailed parts shall be cleaned in accordance with approved procedures before assembly. Particle counts shall be required for process qualification and periodic reliability checks.
(5) All particle counts shall be made using a black or green 0.45 micron, 47 mm diameter membrane filter disc.

(2) Holding clamp.

(3) 250 ml Pyrex glass funnel.

(b) Black or green, 0.45 micron, 47 mm diameter membrane filters with an imprinted grid on 3.08 mm centers.

(c) Filtration flask.

(d) Aspirator or vacuum pump, capable of pulling a minimum of 26 inches of mercury.

(e) Plastic petri-dishes, disposable.

(f) Forceps with unserrated tips.

(g) Sample bottles, small mouth, 4-fluid ounce type, glass etched or otherwise permanently marked to indicate 100 ml sample size.

(h) Microscope with mechanical stage capable of magnifications of approximately 45X and 125X. For 125X magnification, the recommended objective is 10X to 12X.

(i) Eyepieces (2), one with built-in ocular micrometer.

(j) Built-in mechanical stage having a minimum traversing area of 2 inches by 2 inches.

(k) Stage micrometer, 0.1 to 0.01 mm calibrations.

(l) Microscopic lamp, high intensity, variable 500 to 600 candlepower, with focusing illuminating lens. The lamp is to be used as a source of incident light.

(m) Wash bottles, polyethylene.

(n) Suitably cleaned plastic films ("Mylar" or "Saran Wrap"), 2 inches by 2 inches by 0.002 inch.

(o) Vacuum oven capable of handling hydraulic system components.

(p) Ultrasonic equipment (25 kilocycles maximum).

6.7 Materials. - The materials required for the performance of the procedures specified herein shall be as follows and shall meet the requirements of the listed specifications:

(a)	Petroleum	O-E-751
(b)	Isopropyl alcohol	MIL-A-10428
(c)	Trichloroethane	O-T-620
(d)	Trichloroethylene	O-T-634
(e)	Nitric acid	O-A-88
(f)	Hydrofluoric acid	O-H-795
(g)	Trisodium phosphate	O-S-642
(h)	Sodium dichromate	O-S-595
(i)	Ethyl alcohol	O-E-760
(j)	Acetone	O-A-51
(k)	Trichlorotrifluoroethane	MSFC-SPEC-237
(l)	Methanol (methyl alcohol)	O-M-232

6.8 Preparation of filtration equipment. - Each item of the filtration apparatus shall be cleaned before use by the following methods:

(a) Rinse with two successive rinses of solvent.

(b) Using a 1/2-percent water solution of liquid detergent, scrub all parts of equipment.

(c) Rinse with filtered tap water.

(d) Rinse with two separate rinses of filtered alcohol.

(e) Rinse with three successive rinses of solvent that has been filtered through a black or green, 0.45 micron, 47 mm diameter membrane filter disc.

(f) Place equipment under protective cover. Allow to air dry.

6.9 Contamination analysis.

6.9.1 Filter element analysis. - The procedure for determining the downstream cleanliness level of filter elements shall be as specified herein. Filter elements shall be checked upon completion of cleaning and prior to acceptance for installation.

6.9.1.1 Blank analysis. - To determine the contamination level of the fluid and equipment to be used for filter element analysis, the equipment shall be connected in accordance with figure 1 (minus the filter element) and proceed as follows:

NOTE

Letters shown in parenthesis indicate item of equipment shown on figure 1.

(a) Determine that equipment has been cleaned.

(b) Determine that the solvent reservoir (F) contains at least three gallons of filtered solvent.

(c) Close stopcocks (G) and (P) and bleed valve (A).

(d) Using unserrated forceps, remove one black or green, 0.45 micron, 47 mm diameter membrane filter disc from its container. Rinse the grid-printed side of the filter disc with a stream of filtered solvent. Place the filter disc, printed grid side up, on the fritted glass base of the filter holder (N).

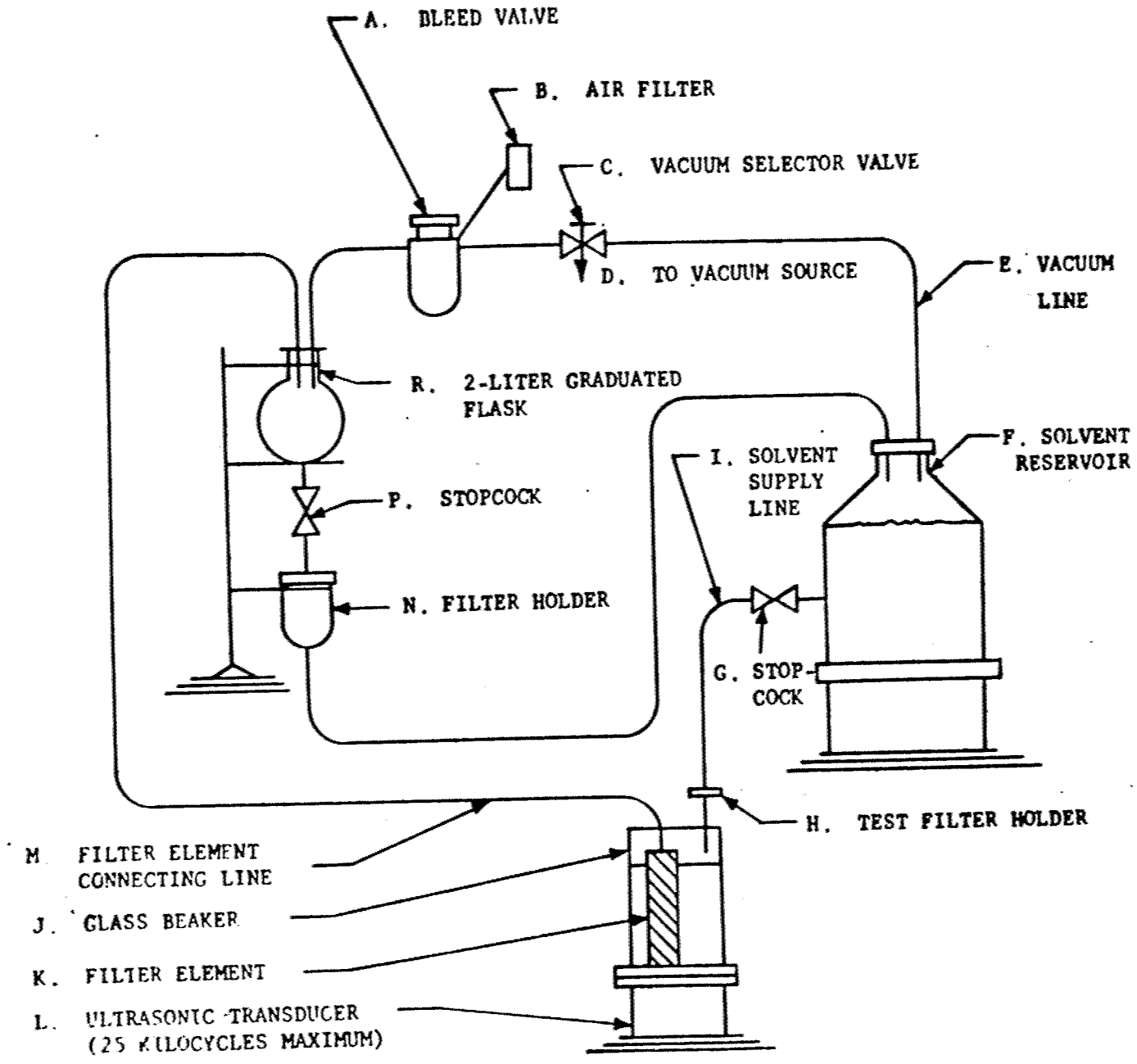

Figure 1. Typical setup for filter element analysis.

(e) Rinse the Pyrex glass funnel with a stream of filtered solvent and immediately lower the filter funnel onto the fritted glass and filter disc. Secure the holding clamp.

NOTE

Do not slide the filter funnel over the filter disc during this step.

(f) Install a black or green, 0.45 micron, 47 mm diameter membrane filter disc in the filter holder (H).

(g) Adjust vacuum selector valve (C) to apply a vacuum to the graduated flask (R).

(h) Open stopcock (G) in solvent supply line (I).

(i) Insert free end of filter element connecting line (M) and free end of solvent supply line (I) into fluid in beaker (J).

(j) Apply vacuum and draw 2 liters of solvent into graduated flask (R).

(k) Close stopcock (G) in solvent supply line (I).

(l) Open bleed valve (A) to relieve vacuum in graduated flask (R).

(m) Adjust vacuum selector valve (C) to close vacuum line to graduated flask (R), and open the vacuum line (E) to the solvent reservoir (F).

(n) Open stopcock (P) between graduated flask and filter holder (N).

(o) Apply vacuum and transfer solvent from graduated flask (R) through filter holder (N) to solvent reservoir (F).

(p) Relieve vacuum from the solvent reservoir when filter disc is dry.

(q) Using unserrated forceps, remove filter disc and transfer, grid side up, to a clean petri-dish.

(r) If microscopic count is not to be made immediately, cover petri-dish and label.

(s) Remove petri-dish cover, and place petri-dish with filter disc under microscope.

(t) Adjust microscopic lamp to obtain maximum particle definition.

(u) Examine filter disc using a magnification of approximately 45X for counting particles 50 microns or larger, approximately 75X for particles 25 to 50 microns in size, and approximately 125X for particles smaller than 25 microns. Count the particles on the total effective filtering area of the filter disc. The particle count shall not exceed the requirements specified in table I.

NOTE

If count is high, repeat steps (d) through (u) until count is acceptable.

6.9.1.2 Filter element. - To determine the cleanliness level of a filter element, equipment shall be connected in accordance with figure 1 and proceed as follows:

NOTE

The filter element to be analyzed shall not be removed from its sealed bag in a contaminated area, or prior to beginning of analysis. The bag shall be opened by cutting and the filter element shall be handled by stainless steel tongs or clean, solvent-resistant gloves to preclude contamination.

(a) Perform blank analysis on the equipment in accordance with 6.9.1.1, steps (b) through (u).

(b) Repeat steps (b) through (e) of 6.9.1.1.

(c) Insert free end of solvent supply line (I) into beaker (J).

(d) Using suitable, precleaned adapter, connect filter element connecting line (M) and place filter element (K) in beaker (J).

(e) Open stopcock (C) in solvent supply line (I).

NOTE

Do not permit solvent level to rise above or go below convolutions on filter element.

(f) Energize ultrasonic transducer (L) to prescribed intensity within 1 minute after immersing the element in the test fluid.

(g) Within 1 minute apply vacuum and draw 500 ml of solvent through the filter element into the graduated flask (R).

(h) Repeat steps (f) and (g) at the end of 4 minutes, 7 minutes, and 9 minutes, respectively.

NOTE

The last 500 ml shall be terminated simultaneously with the completion of the 10-minute period. The solvent level in the beaker shall remain relatively constant during steps (g) and (h).

(i) De-energize ultrasonic transducer.

(j) Close stopcock (G) in solvent supply line.

(k) Open bleed valve (A) to relieve vacuum in graduated flask (R).

(l) Adjust vacuum selector valve (C) and connect solvent vacuum line (E) to vacuum source.

(m) Open stopcock (P) between the graduated flask (R) and the filter holder (N).

(n) Apply vacuum and draw solvent from the graduated flask (R) through the filter holder (N) into the solvent reservoir (F).

(o) Relieve vacuum when filter disc is dry.

(p) Using unserrated forceps, remove filter disc from filter holder and transfer printed-grid side up, to a clean petri-dish.

(q) If microscopic count is not to be made immediately, cover petri-dish and label.

(r) Perform steps (s) and (t) of 6.9.1.1.

(s) Examine filter disc using magnification of approximately 45X for particles 50 microns or larger, approximately 75X for particles 25 to 50 microns in size, and approximately 125X for particles smaller than 25 microns. Examine the total effective filtering area of the disc for particles over 50 microns in size. Count particles smaller than 50 microns in accordance with ARP-598, or other approved method.

(t) Record results and compare to table I.

6.9.1.3 Bubble (pore size) testing. - To determine the maximum pore size of the filter element under test, equipment shall be connected in accordance with figure 2 using ethyl alcohol as the test media and proceed as follows:

(a) Determine that equipment has been cleaned in accordance with 6.8.

(b) Using a suitable precleaned adapter, connect the oil-free (degreased) filter element to the test fixture.

(c) Immerse the filter element in alcohol, keeping the filter element 1/2 inch under the surface of the alcohol.

(d) Slowly apply air pressure and rotate filter element 360 degrees in the alcohol for each change in air pressure.

(e) Increase the air pressure untilthe first bubble appears on the surface of the filter element. The manometer reading at this point is the bubble point (largest pore size) of the filter element. Unless otherwise specified by the procuring activity, the minimum acceptable pore size by this method is 14 inches of water.

6.9.2 Assemblies and components (see 4.1). - All on-board space-vehicle, hydraulic-system items shall be tested to determine contamination level upon completion of assembly and prior to acceptance and prior to vehicle use.

(a) Determine if test equipment fluid supply meets requirements of item 2.(c) of table I.

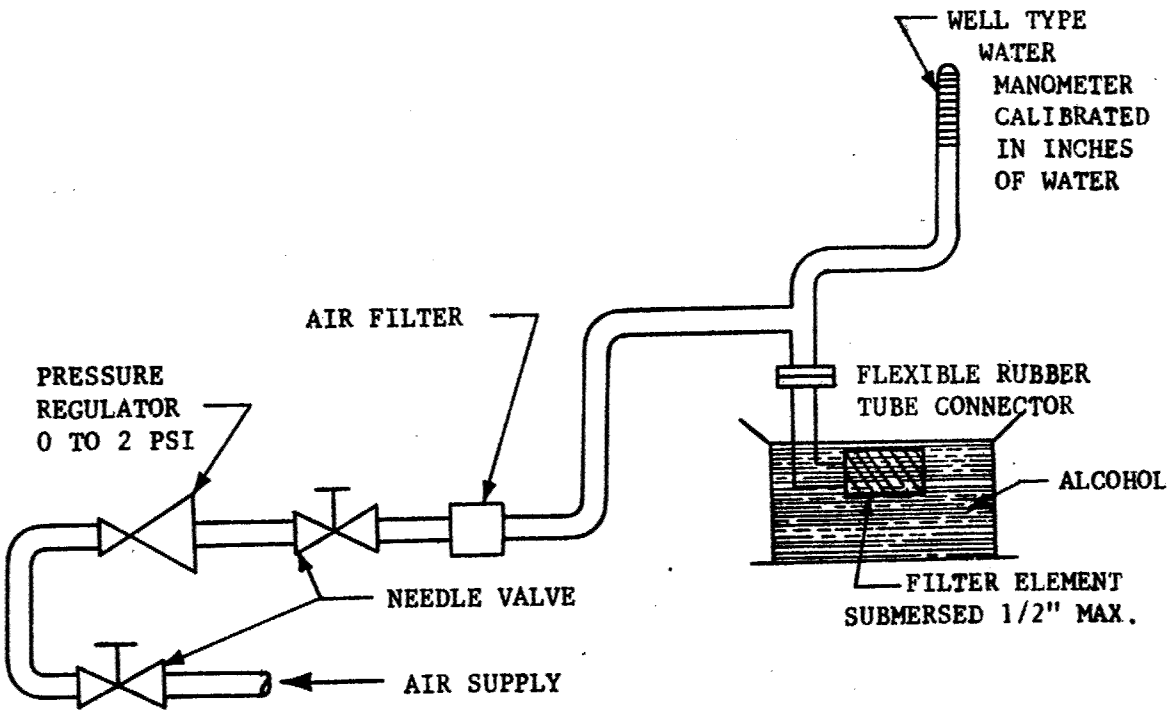

Figure 2. Suggested bubble point (pore size) measuring apparatus.

(b) Place on test bench and evaluate using hydraulic fluid as a media.

(c) Obtain fluid sample as follows:

(1) Thoroughly clean sample point with filtered solvent from a wash bottle.

(2) Open sampling valve and allow a minimum of 100 ml of hydraulic fluid (300 ml when possible) to drain from the sample point into a waste container, then without moving bleed valve, catch 100 ml of fluid in a precleaned bottle.

(d) To test the contamination level of hydraulic fluid and control sample (see note following step 2), use test equipment as shown on figure 3 and proceed as follows:

(1) Using unserrated forceps, remove one filter disc from its container. Rinse the grid-printed side of the filter disc with a stream of filtered solvent. Place the filter disc, grid-printed side up, on the fritted glass base.

(2) Rinse Pyrex funnel with a stream of filtered solvent and immediately lower the filter funnel onto the fritted glass base and secure with holding clamp. Do not slide the filter funnel over the filter disc during assembly and disassembly of funnel.

NOTE

To determine environmental and laboratory analytical equipment contamination not attributable to the assembly or system that is being tested, periodically take a control sample to reflect cleanliness level of sample bottles, filtering equipment, and effectivity of membrane rinsing. Sample shall then be filtered in accordance with step (d). Results shall be no greater than specified in table I.

(3) Apply a vacuum and draw the sample fluid through the filter disc.

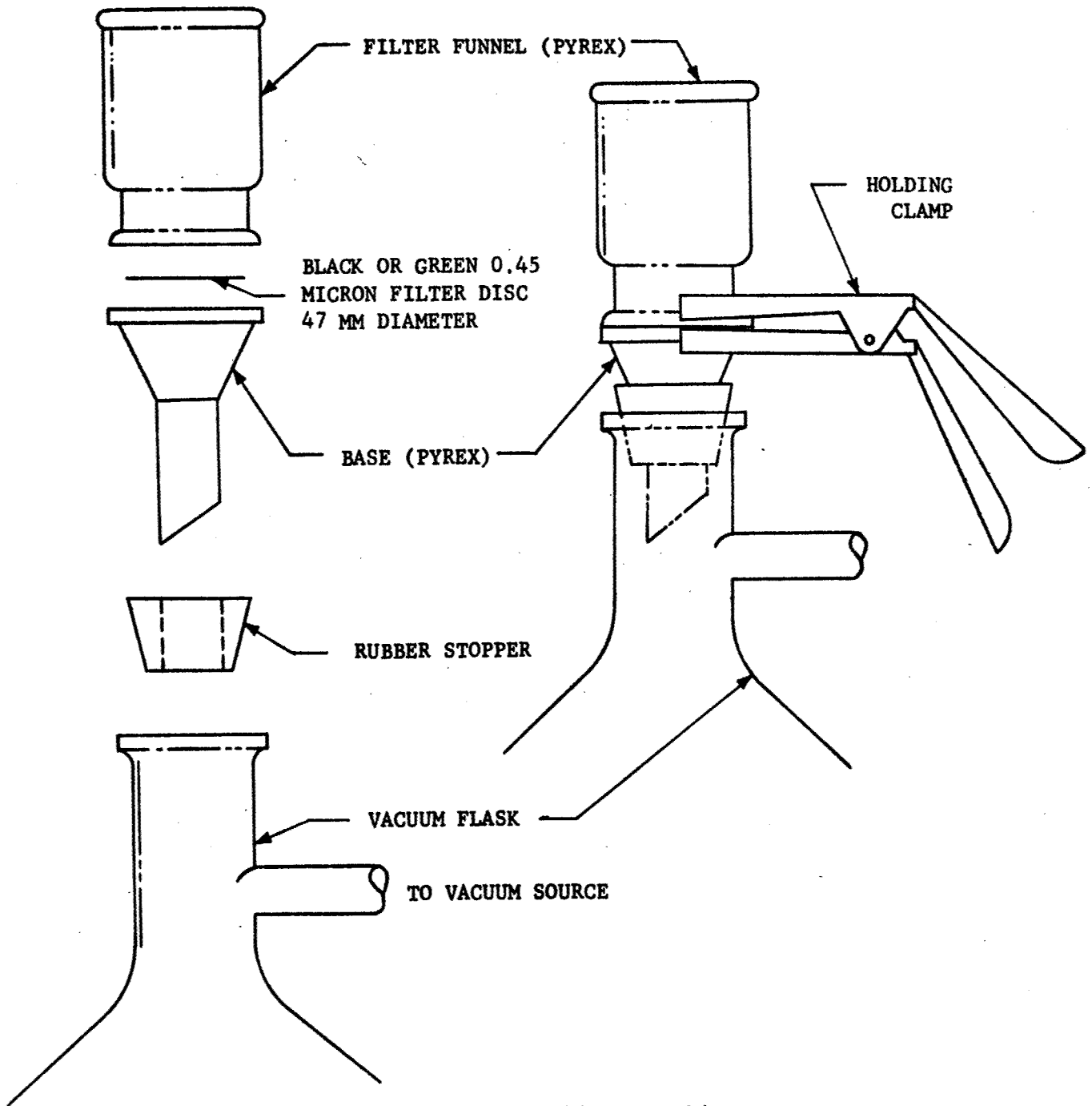

Figure 3. Typical filter holder assembly.

NOTE

After 100 ml sample has passed through the filter disc assembly, rinse the inner walls of the sample bottle with 10 to 15 ml of solvent; pass this solvent rinse through the filter disc.

(4) After the sample has drained through the filter disc, wash the interior of the funnel with filtered solvent to degrease the interior of the funnel and the filter disc.

NOTE

Never strike the filter disc with the stream of solvent.

(5) When the filter disc is dry, relieve vacuum and remove filter disc from filter holder and place in a clean petri-dish, cover, and label.

(6) Perform microscopic examination in accordance with 6.9.1.2 (s) on each filter disc.

(7) Record number, size, and color of particles, and whenever possible, indicate whether the particles are metallic, nonmetallic, etc. for each filter disc.

(8) If particle size limitations as specified in table I are not met, cleaning procedures shall be repeated until requirements are met. Failure to meet specified requirements shall be cause for rejection.

6.9.3 Hydraulic fluids. - Contamination testing of hydraulic fluids shall be performed during cleaning of the fluid, prior to filling GSE, and prior to connection of test supplies to assemblies (pumps, actuators, servo valves, power packages, vehicle systems, etc.) Since the check on particle contamination in the fluid is the same for assemblies and systems, the following procedure will apply:

(a) Prepare equipment in accordance with 6.8.

(b) Obtain sample of fluid from each sample point of item to be checked following procedure of 6.9.2 (c). Label each bottle with name of sample point.

(c) Perform test procedure in accordance with 6.9.2 (d) for each sample point.

NOTE

Counts obtained from samples taken from assemblies before installation (static operation) shall meet requirements of item 4, table I. Counts obtained from samples taken during hydraulic system checkout shall meet the requirements of item 2.(a) or 2.(b) of table I. Counts obtained from samples taken during cleaning of fluid and prior to connection of any test supplies to assemblies shall meet requirements of applicable items of table I. Counts exceeding values specified in table I shall be cause for rejection or purging.

6.10 Cleaning, drying, testing, and packaging procedures (detailed parts) - The following are recommended procedures only. The performing activity may utilize his own procedures (see 6.3). Use of the following recommended procedures will not guarantee acceptance of the end product.

NOTE

Immediately, prior to use, the surfaces of the packaging materials that will come in contact with the part, shall be cleaned and tested to ensure that the surfaces are as clean as the part to be packaged.

6.10.1 Determination of particulate contamination of detailed parts for qualifying and controlling reliability processes.

(a) Flush component with a volume of filtered solvent sufficient to wet all critical surfaces and that is within the volume limits specified in item 3, table I.

NOTE

All equipment that contacts rinsings shall be throughly cleaned prior to use with hot water and detergent, then rinsed with filtered solvent.

(b) Filter test solvent through a black or green, 0.45 micron, 47 mm diameter membrane filter disc.

(c) Examine filter membrane under a microscope having a magnification of 45X to 125X. Measure size of particles in accordance with 6.9.1.1 (u). Compare results with item 3, table I.

NOTE

Levels specified in item 4, table I are final, allowable, gross results. Control counts of filtered solvent shall not be subtracted from test count.

(d) If particle size limiations are not met, reclean as needed and recheck.

6.10.2 Cleaning processes.

6.10.2.1 Uncoated metallic parts, Teflon or Kel-F parts, and metals combined with Teflon or Kel-F.

(a) Vapor degrease the parts by lowering them into solvent vapor until vapor ceases to condense on the surface of the parts.

(b) Flush or circulate solvent at ambient temperature over or through the surfaces of the part for 1 to 2 minutes. For items requiring removal of varnish-type organic material from the surface, immerse the part in acetone for 5 to 10 minutes before vapor degreasing.

WARNING

Kel-F material shall not come in contact with trichloroethylene or trichlorotrifluoroethane. Methyl alcohol is the only approved solvent for use on Kel-F.

(c) Place parts in an ultrasonic bath consisting of a 0.1 to 0.2 percent aqueous detergent solution. Apply ultrasonic energy for 3 to 5 minutes.

(d) Spray rinse or flush parts with demineralized water for 10 to 15 minutes at 90 $\pm$ 20 degrees F or until suds free.

(e) Rinse or flush parts with alcohol to remove water.

WARNING

Kel-F shall be flushed with methyl alcohol only.

NOTE

Parts made of 300 series stainless steel that demonstrate corrosion after processing shall be immersed in a dilute (10 to 20 percent) solution of inhibited phosphoric acid at ambient temperature in an ultrasonic bath for 5 minutes. Rinse the parts thoroughly with deionized water. Rinse or flush parts with alcohol to remove water and determine particulate contamination in accordance with 6.10.1.

(f) Wrap parts in suitably cleaned Saran Wrap, or approved equal, and overwrap with a double thickness of aluminum foil.

6.10.2.2 Coated metallic components.

(a) Carefully scrub the surfaces of the component using a nylon bristle brush saturated with acetone or alcohol to remove any excess contamination.

(b) Scrub the surfaces of the component with a nylon brush saturated with a solution of five parts of Dowell F-33 detergent, or an approved equal, in 1000 parts of demineralized water.

(c) Rinse the component for 10 to 25 minutes in demineralized water at 180 $\pm$ 20 degrees F, or until suds free.

(d) Rinse or flush component with alcohol to remove water.

(e) Determine particulate contamination in accordance with 6.10.1.

(f) Wrap parts with suitably cleaned Saran Wrap, or approved equal, and overwrap with a double thickness of aluminum foil.

6.10.2.3 Nonmetallic components (including metallic components combined with nonmetallic materials other than Teflon or Kel-F).

(a) Flush part with a solution of 5 parts (by volume) detergent to 1000 parts of demineralized water for 10 to 15 minutes at a temperature of 110 $\pm$ 10 degrees F. When feasible, the careful use of a nylon bristle brush may assist in removing contaminants.

(b) Rinse part by flushing or spraying with demineralized water at 110 ± 10 degrees F for 10 to 15 minutes.

(c) Determine particulate contamination in accordance with 6.10.1.

(d) Wrap parts in suitably cleaned Saran Wrap, or approved equal, and overwrap with a double thickness of aluminum foil.

6.10.2.4 Stainless steel tubing (internal surfaces only).

(a) Circulate liquid solvent through tubing for 1 to 2 minutes at ambient temperature and a pump pressure of 30 ± 10 psig.

(b) Remove all traces of solvent by purging with dry air at 180 ± 20 degrees F for 2 to 5 minutes at 15 to 25 psig.

(c) Circulate a solution of 10 ± 2 percent (by weight) of trisodium phosphate at 180 ± 10 degrees F through the tubing for 10 to 15 minutes.

(d) Circulate tap or deionized water at 160 to 180 degrees F through the tubing for 5 to 10 minutes.

NOTE

A pickling solution is to be used at this point, if necessary, for internally corroded or contaminated tubing only. Do not use the pickling solution if the tubing has been cleaned previously by pickling, bright annealing, or other equivalent etchant processes. Protect the flared part of the tubing while circulating an aqueous solution of 20 ± 2 percent (by weight) hydrofluoric acid at a temperature of 90 to 100 degrees F through the tubing for 5 to 8 minutes.

(e) Circulate tap or deionized water at a temperature of 160 to 180 degrees F through the tubing for 5 to 10 minutes.

(f) Passivate the tubing by circulating an aqueous solution of 20 ± 2 percent (by weight) nitric acid and 2.0 ± 0.5 percent (by weight) sodium dichromate at a temperature of 125 ± 5 degrees F through the tubing for 15 to 20 minutes.

(g) Circulate demineralized water at ambient temperature through the tubing until the pH of the effluent is 6 to 8.

(h) Rinse or flush part with alcohol to remove water.

(i) Determine particulate contamination in accordance with 6.10.1.

(j) Wrap tube ends with suitably cleaned Saran Wrap, or approved equal, overwrap with a double thickness of aluminum foil.

6.10.2.5 Teflon line flex hose.

(a) Brush the "B" nuts with solvent using a nylon bristle brush. Flush or spray the "B" nuts and the inside of the hose assembly with solvent, utilizing the pump on the vapor degreaser.

(b) Dry with oil free prefiltered air or nitrogen at ambient temperature or heated to 160 to 180 degrees F.

(c) Circulate a 10 ± 2 percent solution of trisodium phosphate at 180 ± 10 degrees F through the tubing from 15 to 20 minutes.

(d) Rinse with deionized water until pH of effluent is between 6 and 8.

(e) Rinse or flush part with alcohol to remove water.

(f) Determine particulate contamination in accordance with 6.10.1.

(g) Wrap hose ends with suitably cleaned Saran Wrap, or approved equal, and overwrap with a double thickness aluminum foil.

6.10.2.6 Hydraulic actuator.

6.10.2.6.1 Visual inspection. - The following characteristics shall be checked in accordance with the assembly drawing:

(a) Damage to fittings, threads, or other parts of the assembly.

(b) Cleanliness of the assembly.

NOTE

Cleanliness should be verified by vendor certification.

(c) That parts are properly covered to prevent damage during routing.

(d) That actuator is marked with assembly date.

(e) That actuator is marked with cure date of oldest rubber seal used.

(f) That safety wire(s) are attached properly.

6.10.2.6.2 Incoming contamination analysis.

(a) Attach actuator assembly, complete with servo valve, to an approved test fixture.

(b) Connect actuator inlet port to a hydraulic fluid supply having adequate pressure and flow ranges for testing the specific actuator.

NOTE

The hydraulic source influent fluid shall meet the cleanliness level specified in item 2.(c) of table I, and the source shall have adequate filtration to assure minimum specified cleanliness level or better.

(c) Make sure that the connection to the inlet port has a sampling valve installed for taking contamination analysis sample.

(d) Connect actuator outlet port to hydraulic source return. The connection to the outlet port shall have a sampling valve for taking contamination analysis samples.

(e) Open actuator prefiltration bypass valve and flow fluid through actuator and test setup for approximately 10 minutes at rated flow of actuator being tested.

NOTE

During the 10-minute purge, open both inlet and outlet sampling valves and allow approximately 500 ml to flow from each valve.

(f) Close prefiltration bypass valve and apply hydraulic pressure equal to one-third of the rated working pressure of the actuator.

(g) Apply a differential signal to servo valve to fully extend and retract the actuator piston. Open the return line sampling valve when the differential signal is applied and take a 100 ml sample and submit for contamination analysis. The contamination level shall not be greater than the level specified in item 4, table I.

6.10.2.6.3 Functional operation testing. - The actuator shall be tested in accordance with an approved written test procedure for the specific actuator undergoing testing.

6.10.2.6.4 Outgoing contamination analysis. - After all functional testing has been completed, the actuator shall be installed in the test fixture used for obtaining the incoming contamination samples (see 6.10.2.6.2). The outgoing contamination analysis shall be taken as follows:

(a) Open prefiltration bypass valve and allow fluid to flow through actuator and test setup for approximately 20 minutes at rated flow of the actuator. A contamination sample shall be taken from a sample port at the inlet of the actuator during the purge and submitted for analysis. The contamination level shall not be greater than as specified in item 2.(c), table I.

(b) When it has been determined that the contamination level is acceptable, close the prefiltration bypass valve and apply rated pressure to the actuator.

(c) With rated pressure applied, cycle the actuator at 0.5 cps at one-half stroke for approximately 15 minutes.

(d) After cycling for approximately 15 minutes, take two samples, one from the inlet sampling valve and one from the outlet sampling valve with the actuator cycling. The contamination level of the inlet sample shall be as specified in item 2.(c), table I and the outlet sample shall be as specified in item 4, table I. If contamination levels are not met, continue cycling until contamination levels are met.

6.10.2.6.5 Final inspection.

(a) Remove the actuator from the test setup and restore to normal, repeating visual inspection of 6.10.2.6.2.

(b) Assure that a complete data log has been kept on the actuator. This data log shall include incoming contamination analysis results, functional testing results, and outgoing contamination analysis results, component replacements, EO's incorporated, and total running time.

(c) Attach acceptance tag or decal to acceptable actuators.

(d) Overpackage, as necessary, to preclude contamination.

6.10.2.7 Hydraulic pumps.

6.10.2.7.1 Visual inspection. - Perform visual inspection in accordance with 6.10.2.6.1.

6.10.2.7.2 Incoming contamination analysis.

(a) Attach pump to a variable speed drive capable of speeds ranging from zero to maximum rpm of pump to be tested.

(b) Connect the pump inlet into a test setup equivalent to figure 4. The test setup pressure source shall be sufficient for the maximum flow range to the pump, and pressure shall be regulated to the pump inlet requirements specified.

(c) Apply appropriate inlet pressure and open the outlet port sampling valve.

(d) Apply power to the pump drive and increase the speed sufficiently for oil to flow from the outlet port sampling valve. Take three 100 ml samples in the order listed below:

(1) Outlet sampling valve.

(2) Case drain sampling valve.

(3) Supply inlet sampling valve.

1. MOTOR DRIVEN HYDRAULIC PUMP
2. VARIABLE DRIVE UNIT TO 11,000 RPM
3. PRESSURE GAGE, 0 - 100 PSIG
4. PRESSURE GAGE, 0 - 4000 PSIG
5. FLOWMETER, 0 - 20 GPM
6. FLOWMETER, 0 - 2 GPM
7. HAND VALVES, THROTTLING
8. SOURCE OF HYDRAULIC FLUID, UP TO 20 GPM AT 50 PSIG
9. HAND VALVES, SAMPLING
10. PRESSURE RELIEF VALVE

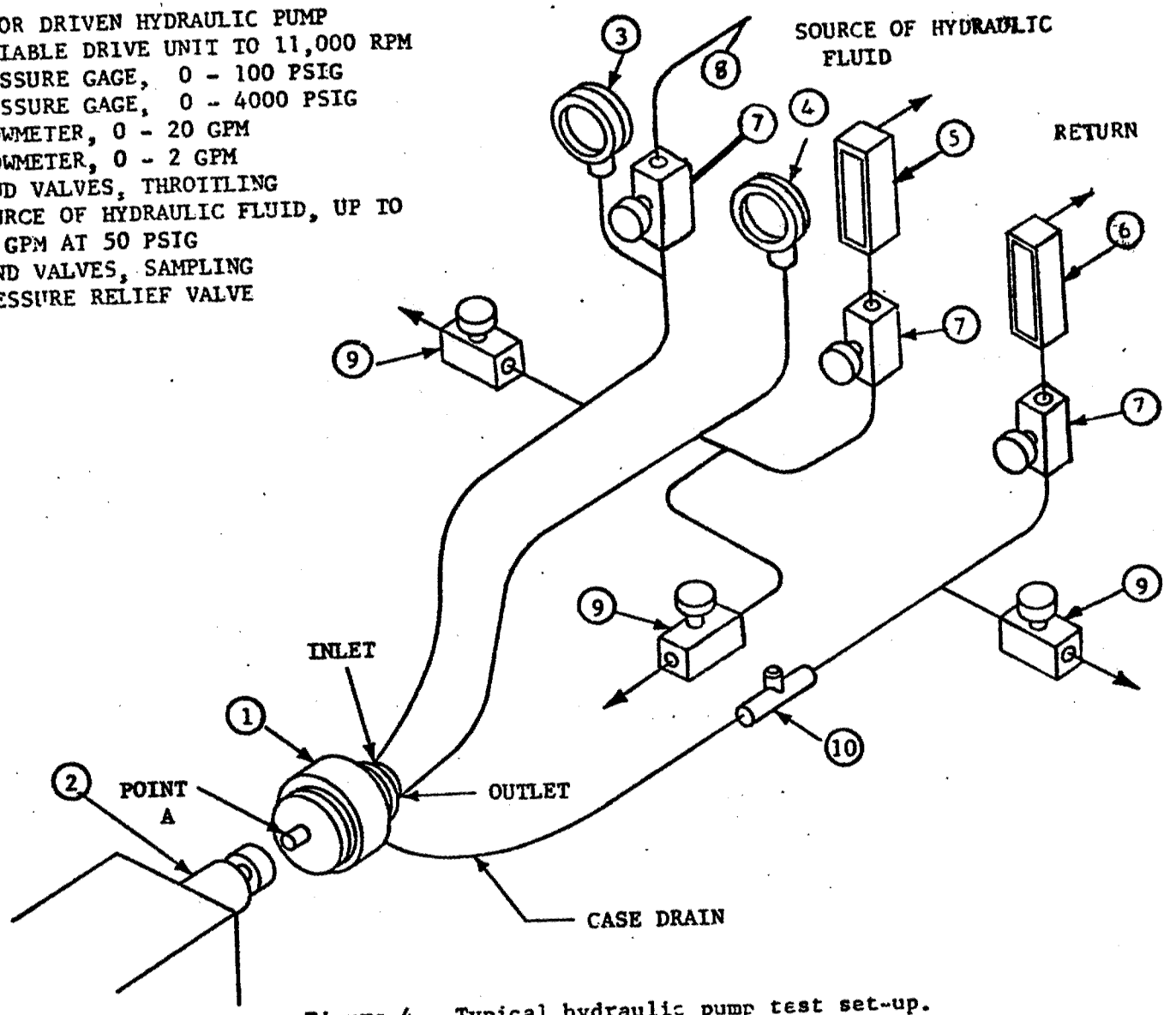

Figure 4. Typical hydraulic pump test set-up.

(e) Submit samples for contamination analysis. The contamination level shall be as specified in item 2. (a), table I for outlet sample, item 2.(b), table I for case drain sample, and item 2.(c), table I for supply inlet sample.

NOTE

The first 100 ml of fluid to flow from the outlet port sampling valve shall be taken because this is the oil that the vendor has shipped in the pump.

6.10.2.7.3 Functional operation test. - The pump shall be tested in accordance with an approved written test procedure for the specific pump undergoing testing.

6.10.2.7.4 Outgoing contamination analysis.

(a) The pump shall be operated at approximately one-half rated speed for a 30-minute final purging.

(b) At the end of the 30-minute purge, sample and evaluate oil from the pump outlet, pump inlet, and case drain. The contamination level shall be as specified in item 2.(a), table I for the outlet sample, item 2.(b), table I for the case drain sample, and item 2.(c), table I for the supply inlet sample.

(c) If contamination level of any one of the three samples fails to meet requirements of table I, continue purging and sampling until the requirements are met.

6.10.2.7.5 Final inspection.

(a) Remove pump from test setup and restore to normal. Repeat visual inspection of 6.10.2.7.1.

(b) Assure that a complete data log has been kept on the pump. This data log shall include incoming contamination analysis' results, functional testing results, outgoing contamination analysis' results, component replacements, EO's incorporated, and total running time.

(c) Attach acceptance tag or decal to acceptable pumps.

(d) Overpackage, as necessary, to preclude contamination.

6.10.2.8 Hydraulic power pack assembly.

6.10.2.8.1 Visual inspection. - Visual inspection shall be performed in accordance with 6.10.2.6.1.

6.10.2.8.2 Incoming contamination analysis.

(a) Remove cap from low pressure relief valve.

(b) Apply 500 psi precharge of GN_2.

(c) Connect high pressure inlet of power pack assembly to a high pressure source having adequate pressure and flow ranges for testing the specific hydraulic power pack assembly.

NOTE

The hydraulic source influent fluid shall meet the cleanliness level specified in item 2.(c), table I, and the source shall have adequate filtration to assure minimum specified cleanliness level or better.

(d) Apply 500 psi to high pressure inlet to power pack assembly and take a contamination analysis sample from bleed valve or sampling valve to the reservoir. The contamination level of the sample shall not be greater than as specified in item 4, table I.

6.10.2.8.3 Functional operation testing. - The hydraulic power pack assembly shall be tested in accordance with an approved written test procedure for the specific assembly undergoing testing.

6.10.2.8.4 Outgoing contamination analysis. - After all functional testing has been completed, the power pack assembly shall be purged and final contamination analysis made as follows:

(a) Cycle the accumulator reservoir for approximately 30 minutes

(b) After approximately 30 minutes of cycling, take two samples, one from the high pressure supply and one from the outlet sampling valve. The high pressure sample shall meet the requirements specified in item 2.(c), table I and the outlet sample shall meet the requirements specified in item 4, table I. If the contamination levels are not met, continue to cycle and sample until they are met.

6.10.2.8.5 Final inspection.

(a) Remove the hydraulic power pack assembly from test setup and restore to normal, repeating the visual inspection of 6.10.2.8.1.

(b) Assure that a complete data log has been kept on the assembly. This data log shall include incoming contamination analysis' results, functional operation test results, and outgoing contamination analysis' results.

(c) Attach an acceptance tag or decal to acceptable hydraulic power pack assemblies.

(d) Overpackage, as necessary, to preclude contamination.

7. REPORTS (Not applicable)

8. MODIFICATIONS

8.1 Any substitutions, deviations, or modifications to this procedure shall be made only with the approval of the cognizant design activity. Submit all recommendations to George C. Marshall Space Flight Center, Huntsville, Alabama, ATTENTION R-P&VE-VNR.

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.

Custodian:

NASA - George C. Marshall Space Flight Center

Preparing activity:

George C. Marshall Space Flight Center

MSFC-PROC-166D
AMENDMENT 2
September 15, 1967
SUPERSEDING
MSFC-PROC-166D
AMENDMENT 1
March 15, 1967

GEORGE C. MARSHALL SPACE FLIGHT CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROCEDURE

HYDRAULIC SYSTEM DETAILED PARTS, COMPONENTS, ASSEMBLIES, AND HYDRAULIC FLUIDS FOR SPACE VEHICLES, CLEANING, TESTING, AND HANDLING

This amendment forms a part of George C. Marshall Space Flight Center (MSFC) Procedure MSFC-PROC-166D, dated February 7, 1967, and has been approved by MSFC and is available for use by MSFC and associated contractors.

(1) Page 8, table I: Delete and substitute attached table I.

Custodian:

NASA - George C. Marshall Space Flight Center

Preparing activity:

George C. Marshall Space Flight Center

Table I. Particle size limitations (3)*

Item	Sample volume (1)	Particle size (microns) (5)				
		*** 0-10	10-25	25-50	50-100	Over 100 and fibers
1. Filter element:						
(a) As released for space vehicle use	2 liters		50,000	4,000	100	10
(b) Blank analysis (filter test equipment)	2 liters		200	75	15	55
2. Hydraulic fluid:						
(a) High pressure onboard system	100 ml		2,150	530	60	10
(b) Low pressure onboard system	100 ml		4,300	1,060	120	10
(c) As released for space vehicle use	100 ml		1,340	210	28	3
(d) As cleaned for issue (fluid used for filling test equipment)	100 ml		670	93	16	1
**(e) Water content						
3. Components (all components that will contact service media including containers, ground support equipment, etc.) (4) Detailed parts process qualification	100 ml/ sq ft		600(2)	100(2)	16(2)	2
4. Assemblies and systems (effluent oil) pumps, servo valves, hydraulic power packs, and servo actuators	100 ml		2,150	530	60	10

*See notes on following page.
**Water content of the hydraulic fluid shall not exceed 100 ppm.
***Particles under 10 microns in size are not counted. However, an accumulation of minute particles of sufficient quantity to cause a haze or partial or complete obscuring of grid lines or any portion of the grid on a test filter membrane, when viewed visually or under 40 power (maximum) magnification, shall be cause for rejection.

MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

I. GENERAL INFORMATION

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☒ Official Record - NRRS 8/12/A ☒ Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)		MB Cook

MJ

14. SPECIAL INSTRUCTIONS:

15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER:	16. ORIGINATING NASA CENTER:	17. OFFICE OF PRIMARY RESPONSIBILITY:
	MSFC MSFC, AL 35812	ED36/Chemistry Group

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20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:

III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION:	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
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IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- ☐ Privacy Act (see MWI 1382.1)
- ☐ Proprietary (see MPD 2210.1)
- ☐ Patent (see MPG 2220.1)
- ☐ ITAR (see MPG 2220.1)
- ☐ EAR (see MPG 2220.1)
- ☐ Other ACI (see NPG 1620.1 and MPG 1600.1) _____
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V. ORIGINATING ORGANIZATION APPROVAL

40. ORG. CODE:	41. PHONE NUMBER:	42. NAME:	43. SIGNATURE/DATE:
ED36	(256) 544-2493	for Mr. Dennis Griffin	Ralph Carruth 10/24/02

VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

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