# AEROSPACE RECOMMENDED PRACTICE

| ARP4285™ | REV. A |
|---|---|

Issued 2001-03
Revised 2018-08
Reaffirmed 2025-01

Superseding ARP4285

## (R) Aerospace - Evaluation of Particulate Contamination in Hydraulic Fluid - Membrane Procedure

RATIONALE

This document has been updated to incorporate technical and editorial changes as a result of the Five-Year review.

ARP4285A has been reaffirmed to comply with the SAE Five-Year Review policy.

FOREWORD

Membrane evaluation using standard membranes, described in this document, is an alternative technique to particle counting with either an optical microscope (AS598) or an automatic particle counter (ISO 11500). The latter particle counting procedures are considered more precise.

This procedure shall not be used as an alternative to particle counting unless agreed to by the customer since the results by this procedure may differ from those by particle counting, even though the standard membrane correlates to a specific particle count.

A particular feature of this method is the membrane preparation to achieve an even particulate distribution on the membrane suitable for other applications.



TABLE OF CONTENTS





**TO PLACE A DOCUMENT ORDER:** **Tel: 877-606-7323 (inside USA and Canada)**
**Tel: +1 724-776-4970 (outside USA)**
**Fax: 724-776-0790**
**Email: CustomerService@sae.org**
**SAE WEB ADDRESS:** **http://www.sae.org**

**For more information on this standard, visit**
https://www.sae.org/standards/content/ARP4285A/

## 1. SCOPE

This SAE Aerospace Recommended Practice (ARP) establishes a method for evaluating the particulate matter extracted from the working fluid of a hydraulic system or component using a membrane. The amount of particulate matter deposited on the membrane due to filtering a given quantity of fluid is visually compared against a standard membrane in order to provide an indication of the cleanliness level of the fluid.

## 2. REFERENCES

### 2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

#### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP5376 Methods, Locations and Criteria for System Sampling and Measuring the Solid Particle Contamination of Hydraulic Fluids

AS598 Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems

AS1241 Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

AS4059 Aerospace Fluid Power – Contamination Classification for Hydraulic Fluids

#### 2.1.2 U.S. Government Publications

Copies of these documents are available online at http://quicksearch.dla.mil.

MIL-PRF-680 Degreasing Solvent

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base; Aircraft; Missile and Ordnance

MIL-PRF-6083 Hydraulic Fluid, Petroleum Base, for Preservation and Operation

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Number H-537

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

#### 2.1.3 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 11500 Hydraulic Fluid Power - Determination of Particulate Contamination by Automatic Counting using Light Extinction Principle.

ISO 14644-1 Cleanrooms and Associated Controlled Environments - Classification of Air Cleanliness by Particle Concentration

2.2 Definitions

2.2.1 MEMBRANE

A commercially available filter membrane through a volume of compatible fluid has been filtered using a specified procedure to deposit particulate contamination from the fluid onto a controlled area of the membrane surface.

2.2.2 MEMBRANE METHOD

A general term identifying a procedure that produces a membrane used to assess the cleanliness of aerospace fluids such as hydraulic fluid.

2.2.3 STANDARD MEMBRANE

A membrane made in an identical manner to other test membranes and specially selected by the contracting parties as representing the contamination limit for that component. It is recommended that the standard membrane correlate to a recognized classification system such as AS4059 or equivalent. It may be an actual single membrane preserved for use between glass slides, or a photograph of an actual membrane and capable of reproduction as agreed by the contracting parties.

3. MEMBRANE PREPARATION

3.1 Membrane Preparation Workroom

The workroom shall be in a clean, draft free area remote from contaminant-generating operations such as testing, grinding, machining, etc., and shared only by similar laboratory-type operations. A clean room or understood environment of ISO 14644-1 Class 8 is recommended.

3.1.1 Workstation

The workstation used to prepare the membrane shall have a hard, continuous surface which can be readily wiped down and may be equipped with compartments and drawers for the various pieces of membrane-making equipment. It may be equipped with a vacuum source capable of 25 in Hg. Alternatively, a manual pump may be used which is vented by detaching the inlet.

3.2 Equipment

3.2.1 General

The Membrane Test Assembly contains components for processing and analyzing hydraulic fluid samples and are described below:

3.2.2 Filter Membranes

These filters consist of a cellulose ester material (or other equivalent material) having a mean pore size of 5 µm or specified by contracting agency. The filter membranes are 47 mm in diameter and are used to filter hydraulic fluid samples. Phosphate Ester fluid per AS1241 requires the use of polytetrafluoroethylene (PTFE) type membranes material (or other equivalent material). Filter membranes having a 3 µm pore size and 25 mm diameter are used to filter the solvent.

WARNING: Filter membranes are highly flammable. Personnel are to take every precaution to preclude flames and sparks from coming in contact with the membranes.

3.2.3 Filter Holder

A test sample, a 47 mm filter holder comprising a filter base and funnel assembly shall be used which consists of a 300 mL Pyrex® receiving funnel and a base with a coarse fretted glass support for the filter, a spring clamp and neoprene stopper (see Figure 1).

3.2.4 Vacuum Filtering Flask

A 1 L filtering flask is used to mount the filter base and funnel assembly. Vacuum is applied to the flask to draw the sample fluid through the filter (see Figure 1).

3.2.5 Graduate Cylinder

A 100 mL graduate is used to measure the volume of sample fluid and solvent to be filtered.

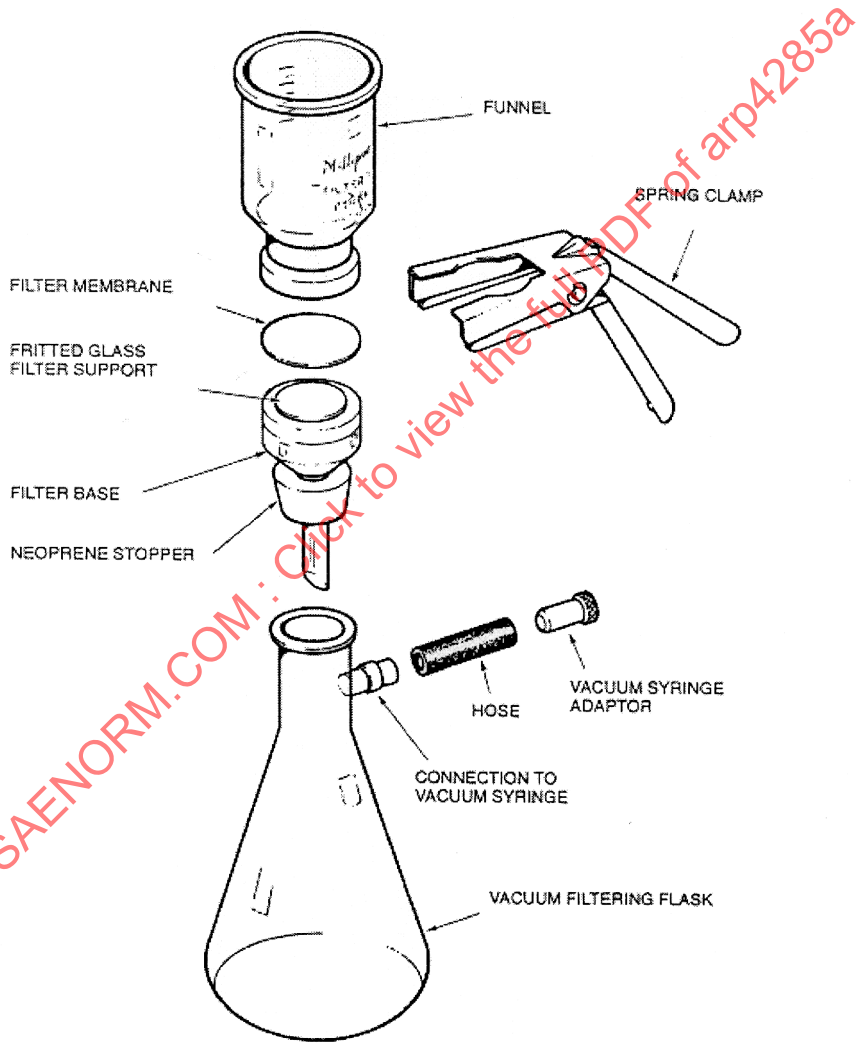




***Figure 1 - Membrane holder and vacuum filtering flask assembly***

3.2.6 Wash Bottle

A solvent filtering dispenser (wash bottle), fitted with a dispensing tube and spout, is used to dispense solvent required in the membrane making process. The wash bottle is fitted with a 25 mm filter holder, to accept a 25 mm (or 24 mm) filter (3 µm), to ensure proper cleanliness of the solvent used during membrane making.

3.2.7 Filter Mounts

Transparent Petri slides with covers hold the 47 mm membranes flat for examination and offer protection from additional contamination during storage.

3.2.8 Forceps

Smooth tipped stainless steel forceps are to be used for handling filter membranes.

3.2.9 Waste Funnel and Drum

The waste funnel and drum are not parts of the basic Membrane Test Assembly but are associated items required in the laboratory set up. A 5 gallon (20 L) drum fitted with a funnel and standpipe to bring the funnel to bench top height is required. This serves as a receptacle for used solvent and hydraulic fluid. Washing of kit parts can be carried out directly over the funnel.

3.2.10 Solvent Supply Drum and Stand

The dry cleaning solvent is supplied in 45 gallon (205 L) drums. The drum should be fitted with a suitable valve and be mounted on a stand to facilitate refilling of the wash bottle.

3.2.11 Reading Card

A card containing some sentences in standard Jaegar 1 (J1) size type is used to aid the operator in establishing the distance from the inspection lens at which the membrane and standards should be viewed.

3.2.12 Inspection Lens

(Optional) An illuminated inspection lens is used for viewing the membranes and standards (suggested magnification 2X).

3.2.13 Additional Equipment

- Lint-free laboratory coats
- Petri dishes

3.3 Consumable Materials

3.3.1 Solvent

The solvent that should be used is to MIL-PRF-680 Type 2 (or as recommended by the contracting agency and as specified by local environmental requirements).

NOTE: Minimum flash point is 140 °F (60 °C). Proper safe handling precautions for dry cleaning solvent shall always prevail.

3.3.2 Additional Consumable Materials

- Filtering disc for wash bottle, 25 mm with 3 µm pore size
- Lint-free rags
- Filter membranes, as defined in 3.2.2, suitable for use with petroleum base hydraulic fluids such as MIL-PRF-5606 and MIL-PRF-6083; and synthetic hydrocarbon oils such as MIL-PRF-83282 and MIL-PRF-87257. This procedure can be utilized with other fluid types as agreed by the contacting parties. Membranes shall be white, ungridded, 47 mm in diameter with a 5 µm pore size or as specified by contracting agencies.

- Filter membranes, as defined in 3.2.2, suitable for use with phosphate ester base oil, AS1241. Membranes shall be white, ungridded, 47 mm in diameter with a 5 µm pore size or as specified by contracting agencies.
- Detergent - general purpose
- Distilled water
- Lens tissue
- Bottles, narrow mouth, flint glass, round, 500 mL (16 ounce) with Polyseal® closures, 28 mm cap size (or as recommended by the contracting agency)

3.4 Pressure Tank and Spray Gun

As an alternative to the wash bottle, these components, when assembled, provide a system to obtain and deliver filtered solvent for bottle cleaning purposes and preparation of the membrane (see Figure 2).



***Figure 2 - Pressurized system for bottle cleaning and membrane-preparation***

Utilize a pressure tank at approximately 100 psi (690 kPa) maximum pressure with a pressure relief valve. Before opening the tank for refilling, the air pressure shall be released through the pressure relief valve, or by other means.

The spray gun is a normal trigger operated unit equipped with a membrane filter unit and nozzle. The membrane filter shall be replaced weekly or more frequently if flow becomes restricted.

### 3.5 Bottle Cleaning Procedure

The approved sampling bottles shall be cleaned prior to performing the cleanliness evaluation of hydraulic fluid. The bottle cleaning procedure for the recommended sampling bottle requires the use of an air pressurized dispensing system with a filter jet solvent dispenser. The air supply can be a central system or a dedicated pump. As an alternative, the wash bottle having the on-line filter can be used to clean sampling bottles.

Upon completion of the Membrane Test evaluation, drain all remaining hydraulic fluid from the 500 mL glass bottle into a waste container. Thoroughly rinse bottle and bottle cap three times with cleaning fluid to ensure cleanliness. After the three consecutive flushings of the bottles, invert bottle and cap to drain as much solvent as possible into waste container. The recapped bottle is then ready for sample taking.

The film of clean solvent (MIL-PRF-680 Type 2) remaining in the bottle will not interfere with subsequent evaluations in regard to particle counting.

NOTE: Proper safe handling precautions for dry cleaning solvent (MIL-PRF-680 Type 2) shall always prevail.

### 3.6 Standard Membranes

Contamination standards, to which membranes are compared, are used for determination of fluid sample acceptability.

## 4. MEMBRANE MAKING PROCEDURE

### 4.1 Precautions

This document may involve hazardous material operations and equipment. This document does not purport to address all the safety problems associated with their use. It is the responsibility of whoever uses this document to consult and establish appropriate safety and health practices and determine the application of regulatory limitations prior to use.

This part provides a description of the procedures necessary for obtaining representative fluid samples, preparing the Membrane Test Kit for use, making membranes using fluid samples and evaluating sample membranes. The various steps in producing a successful membrane from a hydraulic fluid sample are relatively simple and use standard laboratory procedures requiring a period of familiarization of the operator. All steps in the procedure shall be carried out each time in a careful unhurried manner without diversions. A successful membrane is one where a minimum of extraneous contaminant is present. This can only be assured by adhering to proper procedures and by careful attention to cleanliness throughout the membrane making process.

NOTE: Proper safe handling precautions for dry cleaning solvent (MIL-PRF-680 Type 2) shall always prevail.

### 4.2 Sample Taking

A representative hydraulic fluid sample taken from a hydraulic component undergoing evaluation shall be taken in accordance with ARP5376.

### 4.3 Solvent Dispenser

The most important tool used in the membrane making process is the solvent dispenser (wash bottle/pressurized solvent dispenser). It is essential that the solvent wash coming from the dispensing system be as clean as possible to preclude adding outside contaminants during the membrane making process. Filtering the solvent through a 3 μm filter is required prior to use.

#### 4.3.1 Operation

A steady jet of solvent shall be delivered from the solvent dispenser.

4.4 Filter Change

The filter in the top of the wash bottle assembly shall be changed whenever there is evidence of damage or plugging, and on a routine basis as a preventive measure. Plugging of the filter is indicated by difficulty in obtaining a stream of solvent when the wash bottle is operated, or a decrease in pressure when using a pressurized solvent dispenser. Filter damage is indicated by contaminant showing up on a blank membrane.

4.5 Making a Blank Membrane

Blank membranes should be made each day that the Membrane Test Kit is to be used, to ensure cleanliness of the solvent being delivered from the wash bottle or the pressurized dispensing system. Additionally, a blank membrane shall be made after changing the dispensing system filter.

The procedure for making a blank membrane simulates the normal membrane making procedure in respect to the amount of solvent used and time span (see 4.6). The only exception is that a fluid sample is not introduced when preparing a blank membrane.

4.6 Making a Membrane from Fluid Sample

Place the fluid sample bottle and all required kit items in the working area of the bench.

Attach one of the self-adhesive labels to a clean petri slide for identification.

NOTE: Ensure that the vacuum filtering flask has ample free volume to receive the solvent and hydraulic fluid, and that the wash bottle has enough solvent (at least half of the bottle) to go through the entire procedure.

Make a membrane from the fluid sample using the following procedure:

1. Shake the sample bottle gently so as to minimize bubbles, then examine the fluid for any unusual conditions such as cloudiness or visible particulate (not to be confused with bubbles). In the case of a sample displaying these characteristics or other evidence of gross contamination, the technician should use discretion and request a replacement sample. Should the replacement show a similar defect, then appropriate procedures should be implemented to remedy the situation prior to examining further samples. Shake the bottle vigorously for one minute, turning it over several times in the process.

NOTE: Ensure that there is approximately 50 mL of air space between cap of bottle and fluid to obtain better fluid agitation when the sample bottle is shaken. Should the condition of the fluid be other than normal, the membrane maker should use discretion and request a replacement sample immediately.

2. Remove the filter base from the vacuum filtering flask and, holding it over the waste funnel, direct a stream of solvent from the wash bottle over the entire filter area and the funnel interface annulus.

3. Replace the filter base firmly into the vacuum filtering flask. Do not touch the filter area. (If stopper tends to pop out, remedy by washing the stopper and adjacent surface of the flask with solvent from the wash bottle).

4. Wash the tips of the forceps.

5. Pick up the membrane filter with the forceps gripping about 4 mm of the outer edge, and deposit it in the center of the filter base.

NOTE: If static electricity is present, the filter membrane may be repelled from the filter base. To correct this problem, a portion of the membrane may be wetted with solvent to aid in securing the membrane to the base.

6. Hold the receiving funnel over the waste funnel and direct a stream of solvent over its entire inside surface and the flat filter interface.

7. Place the receiving funnel over the filter base.

8. Clamp the assembly together using the spring clamp.

9. Connect the vacuum hose to the vacuum filtering flask.

10. Wash down the inside of the graduate, turning it around its long axis until about 25 mL of solvent has been used. Empty graduate contents into waste funnel.

11. Direct a stream of solvent from the wash bottle or the pressurized dispensing system into the funnel until the level rises to just above the narrow neck of the funnel. Check for external leakage of solvent. If there is a leak, the filter membrane is probably off center and shall be re-centered. The solvent in the funnel should begin to drip slowly into the vacuum flask.

12. Shake the sample bottle again for a few seconds, remove the cap and pour 100 mL of the fluid into the graduate. Replace cap on sample bottle.

13. Operate the vacuum if necessary to promote solvent flow from the receiving funnel, then while there is still solvent in the funnel, up to near the top of the narrow neck, pour in the 100 mL of fluid from the graduate.

14. While the fluid level in the receiving funnel is gradually lowering, direct a stream of solvent into the graduate, turning the graduate around its long axis so that the entire inside surface is washed down. Continue this until the graduate contains approximately 25 mL of solvent.

15. Pour the solvent from the graduate into the fluid of the receiving funnel.

16. Operate the vacuum until the fluid is flowing steadily into the vacuum-filtering flask.

17. When the fluid level in the receiving funnel is approaching the bottom of the wide portion, use the wash bottle to direct a stream of solvent all around the inside of the funnel. The hydraulic fluid and solvent mix will flow more quickly through the filter membrane as dilution takes place. This wash down should be discontinued when the level reaches the narrow neck of the funnel.

18. Observe the filter membrane during the operation for any water droplets and/or smearing which may appear just as the last of the mix passes through.

19. Note any evidence of water.

20. Turn off the vacuum.

NOTE: The following operation shall be done with care so that particle distribution on the membrane is not affected.

21. Using the solvent dispensing system, direct a solvent stream into the receiving funnel at a point about half way down the wide portion of the funnel. The solvent will flow down the side and gently over the membrane. Do not at any time allow the solvent jet to impinge directly onto the membrane but direct it continuously at the same place on the inner wall of the funnel. When the membrane is covered with solvent, turn on the vacuum until the solvent flows through the membrane. See Note.

NOTE: The point at which the solvent is directed onto the inner surface of the funnel should always be the same to permit subsequent washing of the membrane and for marking purposes (see 24). It is suggested that the point directly opposite the vacuum hose connection on the vacuum filtering flask be used as a suitable reference point.

22. Turn off the vacuum.

23. Repeat steps detailed in 21 and 22 above. After all fluid goes through the membrane, operate the vacuum system and hold the vacuum for at least 1 minute.

NOTE: When preparing an AS1241 phosphate ester hydraulic fluid membrane, a third wash as detailed in 21 and 22 shall be carried out.

24. Leaving the vacuum connected, remove the spring clamp, and carefully lift off the receiving funnel leaving the membrane on the filter base. Allow the membrane to dry for about 1 to 1-1/2 minutes; during this time, using the forceps, with tips together, make a small indentation on the outer circumference of the membrane previously covered by the base of the funnel and at a location approximately where the solvent washes (21 and 22) flowed onto the membrane. The purposes of this indentation are to identify the upper (particulate) side of the membrane and the direction in which the final washes were applied.

25. Turn off the vacuum.

26. Insert an unused and dry membrane in the petri slide cover.

NOTE: The use of a dry membrane is to provide a white background to the membrane for visual comparison to a membrane standard, if required.

27. Open the petri slide and, holding it and its cover in one hand, bring it up to the membrane on the filter base. With forceps in the other hand, grip the membrane by its outer circumference and move it into the petri slide containing the dry membrane. Replace petri slide cover.

    The membrane is now ready for the evaluation procedure.

## 5. MEMBRANE EVALUATIONS USING STANDARD MEMBRANES

Having made a membrane according to the above procedure, the remaining task is to evaluate it.

There are two main evaluations:

- The primary evaluation is for the amount of large particulate matter for which the Particle Scan method is used.
- The secondary evaluation is for small particulate matter for which membrane color is used.

The following evaluations determine the acceptability of a fluid to meet the requirements of a standard membrane in accordance with this Aerospace Recommended Practice (ARP). This ARP can be used in lieu of particle counting in accordance with AS4059 or another similar standard, only when approved or required by the customer.

Supplementary evaluation of the membrane may reveal metal particles, extra-large particles and evidence of water. These evaluations will be used to bias the two main evaluations.

Examination of the membrane and comparison with the standards are carried out under the illuminated inspection lens. A standard Jaegar I (J1) card may be used to adjust the focal distance for the membrane evaluation.

### 5.1 Particle Scan

This is for large particulates.

NOTES:

1. The term ‘Particle Scan’ means an intent look at the entire area of the membrane. It does not involve any actual particle counting but is a comparison of the amount of particulate matter seen on a membrane to that seen on the appropriate standard.

2. Very dirty membranes are readily identified while membranes close to standards are more difficult to evaluate. As the operator gains experience and skill in the Particle Scan method, there will be a progressive improvement in the percentage of correct evaluations.

3. A correctly made membrane will have an acceptable distribution of particulate matter. Where there are a few large particles, these may not appear uniformly spaced because of their small number. The distribution is considered acceptable unless there are conglomerates of a large number of particles in a small area spaced between very clean areas, which indicate some fault in the final washing process requiring a replacement membrane to be made.