



AEROSPACE RECOMMENDED PRACTICE

ARP5941™

Issued 2008-03
Reaffirmed 2020-10

Aerospace Fluid Power - Contamination Sensitivity -
Considerations for Establishing Test Procedures for Flight Control Actuators

RATIONALE

ARP5941 has been reaffirmed to comply with the SAE five-year review policy.

TABLE OF CONTENTS

1.	SCOPE.....	2
2.	APPLICABLE DOCUMENTS.....	2
2.1	SAE Publications.....	2
2.2	NFPA Publications.....	2
2.3	National Aerospace Standards Publications.....	2
2.4	ISO Publications.....	3
3.	BACKGROUND.....	3
3.1	Introduction.....	3
3.2	History.....	3
3.3	Requirements.....	4
4.	TEST PROCEDURES.....	4
4.1	General.....	4
4.2	Endurance.....	5
4.2.1	Conditions for Endurance Test.....	5
4.2.2	Detailed Test Procedure.....	5
4.2.3	Success Criteria for Endurance Test.....	6
4.3	Silting Test.....	6
4.3.1	Conditions for Silting Test.....	6
4.3.2	Success Criteria for Silting Test.....	7
4.4	Test Setups.....	7
5.	NOTES.....	7

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2020 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

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
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE ARP5941

For more information on this standard, visit
<https://www.sae.org/standards/content/ARP5941>

Documents
Document Sharing Hub

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) describes the design conditions under which tests should be conducted to demonstrate satisfactory performance of a flight critical servo-actuator under the maximum allowable particulate contamination in the associated airplane hydraulic system. Additionally, this document also describes the recommended tests and the required acceptance criteria.

2. 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.

The documents listed herein and referenced throughout the text should be consulted in the design of the contamination sensitivity test setup and the conductance of the test.

2.1 SAE Publications

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

ARP219	Procedure and Method for Conducting Test of Hydraulic Components in Contamination Controlled System
ARP598	Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems
AS4059	Aerospace Fluid Power - Cleanliness Classification for Hydraulic Fluids
J2470	Hydraulic Fluid Power - Valves - Method for Assessing the Leak Sensitivity to Contaminants

2.2 NFPA Publications

Available from National Fluid Power Association, 3333 N. Mayfair Road, Suite 211, Milwaukee, WI 53222-3219, Tel: 414-778-3344, www.nfpa.com.

T.3.9.18 R1-1978	Flow degradation for fixed displacement hydraulic pumps - (Note: Withdrawn without a superseding document)
T.3.5.48 1994	Procedure for Evaluating Hydraulic Fluid Power Valves (Note: Rescinded, revised version issued as SAE J2470)

2.3 National Aerospace Standards Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 1638	Cleanliness Requirements of Parts Used in Hydraulic Systems (Note: Inactive for new design and superseded by AS4059)
----------	--

2.4 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 11171 Hydraulic fluid power - Calibration of automatic particle counters for liquids

3. BACKGROUND

3.1 Introduction

The primary risks to satisfactory operation of flight critical servo-actuators due to particulate contamination could be valve jamming through blockage or silting and valve erosion. Fluid contamination may be a single cause affecting operation of both control and monitor components such as a control valve and a by-pass valve, which are supposed to be independent.

The airframe manufacturer and/or group applying the part to the airplane should determine whether or not these tests apply to a part. It may be relevant to apply this to parts that are not flight critical, and, conversely, it may not be relevant to apply this to parts that are flight critical.

These tests also include a segment that assures the component's fault tolerance for particulate contamination conditions during which the allowable level may be unintentionally exceeded during airplane operation.

Provided herein are

- Background for the rationale of the test
- Definitions when such a test is to be performed
- Outlines of the tests to be conducted
- Success criteria for the tests.

What is not provided herein are

- How the test is to be conducted
- How the contaminants are to be induced
- How the contaminant level is to be controlled
- The composition of the contaminant.

The reason for the absence of these parameters is: No commonly accepted method exists nor is there agreement as to what can realistically be implemented. Nevertheless some guidance is provided. The specifics of these tests are to be established between the Procuring Agency and the Supplier.

3.2 History

Typically, Flight Control actuators were designed to specifications requiring operation with maximum contamination levels of NAS 1638 Classes 7 or 8. NAS 1638 has been superseded by AS4059 and the contamination classes of AS4059 are equivalent. They were qualified utilizing test stands and aircraft with contamination levels meeting those requirements. Typically the test stands were maintained at even cleaner levels. Commercial aircraft fleet surveys have revealed that the fleet operates often at higher-than-recommended contamination levels (as high as Class 12 was reported). They did so without experiencing any noticeable performance degradation. This observation provided some of the background for the above mentioned SAE recommendation, namely to allow operation at Class 9 level, or better. Most aircraft manufacturers currently define maximum in-service particulate contamination as NAS 1638 or AS4059 Class 9. This followed the recommendation by the SAE A-6 Committee to the FAA.