

AEROSPACE RECOMMENDED PRACTICE

SAE ARP4268

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Issued 1989-10
Revised 1994-02
Cancelled 1999-01

Superseded by ARP5386

Submitted for recognition as an American National Standard

Aerospace Hydraulic System Fluid Contamination - Location of Sampling Points

1. SCOPE:

The scope of this Aerospace Recommended Practice (ARP) covers where, when, and how often to sample hydraulic system fluid on aerospace vehicles for particulate contamination measurements.

The measurement of hydraulic fluid particulate contamination is of concern to the aerospace community because of the critical importance of hydraulic equipment reliability. Contamination is always present in the system fluid, even in new unused fluid. Contamination must be below a level that will not adversely affect system operation. This ARP draws from aerospace industry experience and practice to establish criteria for fluid contamination sampling recommendations in aerospace vehicle hydraulic systems. Fluid samples can then be subjected to measurement of particulate contamination and of other harmful contaminants such as chlorinated solvents and water.

2. REFERENCES:

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| ARP598 | The Determination of Particulate Contamination of Liquids by the Particulate Count Method |
| ARP1192 | Procedure for Calibration and Verification of Liquid-Borne Particle Counter: An Absolute Standard |
| ARP1922 | System Integration Factors that Affect Hydraulic Pump Life |
| AIR4057 | Secondary Filters for Fluid System Reliability |
| AS4059 | Aerospace-Cleanliness Classification for Hydraulic Fluids |
| NAS1638 | Cleanliness Requirements of Parts Used in Hydraulic Systems |
| ISO 5884 | Aerospace - Fluid Systems and Components - Methods for System Sampling and Measuring the Solid Particle Contamination of Hydraulic Fluids |

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3. PURPOSE OF SAMPLING:

The purpose of sampling is to obtain a representative fluid sample to determine the contamination level of the system fluid. Contamination level sampling provides the basis to assure proper hydraulic system operation relating to acceptable levels of contamination, indication of incipient system degradation due to particulate build-up, and adequacy and efficiency of system filtration.

The major source of particulate contamination is wear of system components caused by recirculation of particulates in the fluid. Chemical contaminants, cavitation and electrochemical erosion, and external contamination sources such as maintenance actions also contribute to wear.

4. LOCATION OF SAMPLING POINTS:

- 4.1 The hydraulic system designer shall select the hydraulic system sampling point(s) at the time of design for fleet standardization consistent with system cleanliness requirements. Users may require optional sampling points, to satisfy their peculiar maintenance requirements.
- 4.2 The sampling point(s) shall be located in a readily accessible area and shall allow convenient use of sampling containers. For standards refer to ISO 5884.
- 4.3 The following sampling points relative to system filters will provide fluid from various points in the system with different cleanliness levels.
 - 4.3.1 Upstream of the main return filter provides indication of contamination coming from system components.
 - 4.3.2 Upstream of the hydraulic pump case drain filter provides indication of contamination coming from the hydraulic pump. The pump case drain fluid can be the system's most heavily contaminated area due to pump generated wear particles.
 - 4.3.3 Downstream of the main return filter and upstream of the hydraulic pump verifies filter performance and provides indication of contamination going to the reservoir and pump. The case drain line may also contribute considerable contamination to the reservoir depending on system configuration.
 - 4.3.4 Downstream of the main pressure supply filter provides indication of contamination going to the actuation system. In the supply side of the hydraulic system, the contamination level is lowest at the outlet of the pressure filter and is increased by debris picked up on the way to the actuation system. Secondary filters are often installed immediately upstream of sensitive components to protect them from large particle debris.
 - 4.3.5 Locations at the hydraulic reservoir and at filter bowls are not recommended for particulate contamination measurement, no matter how convenient. Samples from these points do not provide clear stream full flow conditions and are not considered representative of the hydraulic system fluid.

5. SAMPLING TIME:

- 5.1 Full flow conditions are required for obtaining a truly representative particulate contamination sample. When this is not practical, the hydraulic fluid sample should be taken as soon after landing as possible on aircraft, and after exercising the hydraulic system with ground power.

6. SAMPLING FREQUENCY:

- 6.1 The sampling frequency shall be selected and monitored by the operator as required to meet the needs of contamination control. The time between samples shall be based on operating experience in anticipation of reaching the specified allowable contamination level. The time between samples should be increased prudently with introduction of a new model aerospace vehicle. Initial sampling frequencies of 6 to 12 months or 1500 h, whichever comes first are recommended.
- 6.2 Sampling is recommended following failure and/or replacement of system components. Change out of system filters is also recommended following component failure.
- 6.3 The prime manufacturer shall sample the hydraulic fluid after initial flushing during manufacture and at the time of delivery.

7. SUMMARY:

- 7.1 Each hydraulic system in aerospace vehicles shall have a hydraulic fluid sampling point or points with convenient access, and located by the hydraulic system designer consistent with the design concept of fine filtration or of dirt tolerant components.
- 7.2 The fluid is expected to be cleaner downstream of filters. The fluid cleanliness specification must take this fact into account.
- 7.3 Fluid samples should be taken at specified times for consistency. The recommended time for taking fluid particulate contamination samples is during full flow operating conditions, or if not practical, during conditions approximating as closely as possible full flow conditions.
- 7.4 The frequency of taking samples is selected to meet the needs of contamination control, based on the applicable operator experience and criteria.

8. RECOMMENDATIONS:

A number of potential sampling point locations exist in a vehicle hydraulic system to obtain fluid samples for contamination measurement. The location upstream of the return line filter is considered to be the single most representative point for sampling the total system fluid particulate contamination level.