The Engineering Society For Advancing Mobility Land Sea Air and Space ®

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AEROSPACE STANDARD

AS4059

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AEROSPACE-CLEANLINESS CLASSIFICATION FOR HYDRAULIC FLUIDS

1. SCOPE:

1.1 This SAE Aerospace Standard defines cleanliness levels for particulate contamination of hydraulic fluids and includes methods of reporting data relating to the contamination levels. The contamination levels selected are an extension and simplification of the widely accepted NAS 1638.

1.2 Purpose: The intent of this standard is to establish the minimum information required to allow valid comparison and interpretation of contamination levels in hydraulic systems that require contamination control of particulate to insure system performance and reliability.

2. REFERENCE DOCUMENTS:

The latest issues of the following documents form a part of this specification to the extent specified herein:

ARP598 - The Determination of Particulate Contamination in Liquids by the Particle Count Method
AIR877 - Particle Count Data Conversion and Extrapolation
ARP1192 - Procedure for Calibration and Verification of Liquid-Borne Particle Counter: An Absolute Standard
NAS 1638 - Cleanliness Requirements of Parts Used in Hydraulic Systems

3. CLEANLINESS CLASSIFICATION:

NAS 1638 has been widely used in the aerospace industry for specifying system fluid cleanliness in hydraulic systems. Because of its long use and familiarity, its classes have been retained as a basis for AS4059. This AS extends NAS 1638 to include cumulative measurement of particulate contamination in the fluid down to 2 micrometers and Class 000. In addition, AS4059 simplifies the reporting and interpretation of contamination data.

3.1 Cleanliness Level: Table 3-1 lists the cleanliness classes established to provide a set of criteria for specifying fluid cleanliness levels. The classes are based on contaminant size, count and distribution.

TABLE 3-1 - AS4059 Cleanliness Classes

Size/ Micrometers	000	00	0	1	2	3	4	5	6	7	8	9	10	11	12
> 2	164	328	656	1309	2621	5245	10 491	20 975	41 950	93 900	167 798	335 595	671 191	1 342 382	2 684 764
> 5	76	152	304	609	1217	2432	4864	9731	19 462	38 924	77 849	155 698	311 396	622 792	1 245 584
>15	14	27	54	109	217	432	864	1731	3462	6924	13 849	27 698	55 396	110 792	221 584
>25	3	5	10	20	39	76	152	306	612	1224	2449	4898	9796	19 592	39 184
>50	1	1	2	4	7	13	26	53	106	212	424	848	1696	3392	6784

3.2 Application of Cleanliness Levels: The cleanliness levels of Table 3-1 apply to particle sizes and counts per 100 mL sample of fluid.

4. PROCEDURE:

4.1 Measurement of Cleanliness Level:

4.1.1 Measurement: Cleanliness shall be measured in accordance with microscopic counts per ARP598 or counts with an automatic particle counter calibrated per ARP1192.

4.1.2 Sampling: Sampling bottles and sampling systems for Class 2 and above shall be pre-cleaned to a level not exceeding Class 0. Sampling equipment used for measuring levels cleaner than Class 2 shall be at least two classes lower or 25% of the sample cleanliness level.

4.1.3 High Contamination Concentration: High levels of contamination may saturate automatic particle counters, therefore, counts greater than 75% of the saturation level of the counter may be suspect. If it is necessary to count particles at a level approaching saturation or greater, it will be necessary to dilute the sample accordingly. Dilution, however, must be approached with caution. The dilution fluid must be very clean, Class 0 or better, and must be compatible with the hydraulic fluid and the optical qualities of the fluid used in APC calibration. (See 7.3 and section 9.)

5. REPORTING DATA:

The fluid cleanliness classification is determined from Table 3-1 by the number of particles greater than 5 micrometers.

At the discretion of the procuring agency, 2 μm or 15 μm may be specified in lieu of the standard 5 micrometers. Plot all particle counts greater than 2, 5, 15, 25, and 50 μm per 100 mL, and list other data on Fluid Cleanliness Data Sheet in AS4059 (Fig. 1). It should be noted that if cumulative particle counts greater than 25 and 50 μm are used to determine the cleanliness class, these points will not lie on the extrapolated straight lines of Fig. 1.

6. DERIVATION OF CLEANLINESS CLASSES:

The cleanliness classes have been developed from NAS 1638 particle counts, which are defined by particle size ranges. Herein, NAS 1638 particle counts by range are presented as cumulative values. A 2 μm cumulative count is also included for procuring agencies who wish to acquire particle control to this finer level. The greater than 2 μm counts in Table 3-1 have been derived by the extrapolation of the straight lines through the greater than 5 and greater than 15 μm counts. The AS, however, does not recommend the imposition of the 2 μm option for the higher numbered classes. In addition, the cleanliness levels have been expanded to include a 000 Class. NAS 1638 counts, for particles greater than 100 μm, have been incorporated in counts for particles above 50 μm herein.

7. LESSONS LEARNED:

7.1 Limitations of Data: The assumption is made that the particle count distribution curves of the cleanliness classes approximate a straight line when plotted on Log/Log2 graph paper.

7.2 Explanation for Variance: The hydraulic fluid system cleanliness levels will be affected by filter performance. The filter, depending on its efficiency, will allow particles of smaller size ranges to pass through the filter and recirculate in the system.

7.3 Dilution: Care must be exercised when the fluid sample is diluted in order to reduce particle counts to within manageable numbers. Dilution creates two major problems. First, any error in dilution will be reflected in total counts. Second, the dilution fluid will contain some particles of various sizes resulting in an erroneous increase in particle counts. With these problems in mind, it is obvious that extremely high cleanliness levels of the dilution fluid and accurate measurement of dilution ratio are necessary.

7.4 Sampling Error: Extracting a fluid sample from a fluid system may generate large particles, which can enter the sample. This will distort the contamination count.

When particle counts for one of the classes has an unusually high count in the larger micrometer size range, the sampling device or technique, or both, should be considered as a cause. The sampling should be repeated until two samples fall within the same class for the particle size range of concern and the standard 5 μm size range or the size range used for determining the cleanliness class.

8. ESTABLISHING CLEANLINESS CLASSIFICATION TRENDS:

The implementation of this document will help maintain a record of actual system counts. The information collected will be valuable when evaluating cleanliness level trends.

9. PARTICLE SIZE:

The first concern is a function of the particle counting technique. The counting procedure used may be limited by the maximum concentration of particles. High concentrations affect the counts taken by automatic particle counters and are tedious to count by microscope. To obtain counts for samples with high particle concentration, dilution must be used. The second concern is counting 2 μm size particles. The particle counter used must have a demonstrated capability of obtaining valid counts in the 2 μm size. Capabilities of particle counters, claiming the ability to count in the 2 μm must be verified by calibration per ARP1192.

Prepared by SAE Subcommittee A-6C, Fluid Power Distribution Elements of the SAE Committee A-6, Aerospace Fluid Power and Control Technologies