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SAE INTERNATIONAL
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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1165

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Submitted for recognition as an American National Standard

REPORTING CLEANLINESS LEVELS OF HYDRAULIC FLUIDS

***Foreword*—**This Reaffirmed Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. ***Scope*—**This SAE Recommended Practice has been formulated to advance and endorse the use of the ISO (International Organization for Standardization) Solid Contaminant Code as the universal means for expressing the level of particulate contaminant in hydraulic fluid and for specifying acceptable limits of cleanliness. Worldwide approval was gained for this coding system because it provides a simple, unmistakable, meaningful, and consistent means of communication between suppliers and users. The code applies to all types of hydraulic (liquid) fluids used in fluid power and control systems as applied to self-propelled machines as referenced in J1116.

1.1 **Purpose—**The purpose of this recommended practice is to provide a practical and uniform method for graphically representing the contamination level of a fluid and assigning its proper ISO Cleanliness Code. Although the approval code is explicit and offers no opportunity for misinterpretation, flexibility in application is provided to satisfy the customs of the cooperating nations. This recommended practice is intended to facilitate the use of the ISO code and encourage its promulgation throughout the industry.

2. ***References***

2.1 **Applicable Publication—**The following publication forms a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1116, Categories of Off-Road Self-Propelled Work Machines

3. ***Background*—**Many attempts have been made to devise an ideal means for ranking the contamination level of hydraulic fluids with respect to the particle size population. The most notable of these are the disavowed SAE, ASTM, and AIA Levels, NAS 1638, and MIL-STD-1246A. Since these methods were predicated on the existence of fixed contaminant distributions, they are no better than using the two fundamental characteristics of the contaminant - the gravimetric level and the particle concentration of a specified distribution per unit volume of fluid. The cleanliness level spectrum covered by the various methods is reflected in Table 1. Basically all of the methods assume a fixed particle size distribution (roughly corresponding to that of ACFTD) except the ISO Solid Contamination Code.

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The approved coding system is based on the fact that a step ratio of two for particle concentration is adequate both to differentiate between two significantly different systems and also to allow for reasonable differences in measurement. Range numbers are used to identify each step in particle population throughout the spectrum of levels. To allow measurements to be taken from differing fluid volumes, the numbers of particles counted above 5 and 15 μm respectively are normalized on either a one milliliter or 100 milliliter basis and reported in terms of pairs of range numbers. Thus, a theoretically infinite number of range pairs is available to describe the contamination level of a fluid.

The ISO Solid Contaminant Code is assigned on the basis of the number of particles per unit volume greater than 5 and 15 μm in size. These two sizes were selected because it was felt that the concentration at the smaller size would give an accurate assessment of the silting condition of the fluid, while the population of the particles greater than 15 μm would reflect the prevelance of wear catalysts. Thus, the particle size distribution by the ISO coding system is described by a 5 μm range number and a 15 μm range number (with the two numbers separated by a solidus).

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TABLE 1—CLEANLINESS LEVEL CORRELATION TABLE

ISO Code	Particles per milliliter > 10 µm	ACTFD[1] Gravimetric Level - mg/L	MIL-STD-1246A (1967)	NAS 1638 (1964)	Disavowed "SAE" Level (1963)
26/23	140 000	1000			
25/23	85 000		1000		
23/20	14 000	100	700		
21/18	4500			12	
20/18	2400		500		
20/17	2300			11	
20/16	1400	10			
19/16	1200			10	
18/15	580			9	6
17/14	280		300	8	5
16/13	140	1		7	4
15/12	70			6	3
14/12	40		200		
14/11	35			5	2
13/10	14	0.1		4	1
12/9	9			3	0
11/8	5			2	
10/8	3		100		
10/7	2.3			1	
10/6	1.4	0.01			
9/6	1.2			0	
8/5	0.6			00	
7/5	0.3		50		
6/3	0.14	0.001			
5/2	0.04		25		
2/0.8	0.01		10		

1. ACFTD (Air Cleaner Fine Test Dust) - ISO approved test and calibration contaminant.

3.1 Data Acquisition—In order to assign an ISO cleanliness code to represent the contamination level of a fluid, the number or particles greater than 5 and 15 µm per unit volume must be available. Furthermore, the particle population must be obtained from a particle counting system which has been calibrated per ISO/DIS 4404 or an ISO approved equivalent method in order to assign a valid cleanliness code. The actual counting system is immaterial as long as the acceptable calibration certification is available.

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TABLE 2—ISO RANGE NUMBER TABLE

Particle Concentration (Particles per millimeter)	Range Number
10 000 000	30
5 000 000	29
2 500 000	28
1 300 000	27
640 000	26
320 000	25
160 000	24
80 000	23
40 000	22
20 000	21
10 000	20
5000	19
2500	18
1300	17
640	16
320	15
160	14
80	13
40	12
20	11
10	10
5	9
2.5	8
1.3	7
0.64	6
0.32	5
0.16	4
0.08	3
0.04	2
0.02	1
0.01	0.9
0.005	0.8
0.0025	0.7

NOTE—If a cumulative particle count falls between two adjacent particle concentrations, the proper Range Number needed to formulate that portion of the ISO Contaminant Code is found opposite the higher particle concentration. For example, if the number or particles per milliliter greater than 5 µm is 3000, the appropriate Range Number is 19; and similarly, if the cumulative particle concentration at 15 µm is 90, the corresponding Range Number is 14. Therefore, the ISO Solid Contaminant Code is 19/14.

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3.2 Code Designation—There are two ways that the ISO code can be assigned. The first is by adhering rigidly to a tabular method of identifying the correct pair of Range Numbers needed by the code, and the second is by plotting the results of the actual particle count measurements on a specially prepared graphical background displaying the Range Number spectrum.

The tabular method utilizes Table 2, in which each Range Number corresponds to a concentration limit for the specific cumulative particle counts. The appropriate Range Numbers for both the 5 and 15 μm particle counts can be obatined from Table 2.

The graphical method utilizes the particle size distribution graph shown in Figure 1. The ISO Range Number scale is overlayed to facilitate the visual assignment of the ISO code. The mechanics of the coding technique are illustrated by appropriate examples in Figure 1. The graphical method offers additional insight regarding the slope and displacement of the distribution curve which is not afforded by the tabular method.

3.3 Correlation—For those entrenched with one of the deprecated methods for expressing contamination levels, Table 1 has been included to help transpose from one system to another. It is intended that this table be eliminated in future reviews of this recommended practice.

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