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Impact of Changes in Test Dust Contaminants and Particle Counter Calibration on Laboratory Filter Element Performance and Fluid Cleanliness Classes

1. SCOPE:

This SAE Aerospace Information Report (AIR) discusses the impact of the ISO Test Dusts, chosen as replacement contaminants for the Arizona Test Dusts (AC Test Dusts), and the ISO calibration procedure ISO 11171 for automatic particle counters, which replaces the calibration procedure ISO 4402 (1991), on laboratory performance of filter elements utilized in aerospace lubrication, hydraulic and fuel systems, and fluid cleanliness levels determined with automatic particle counters.

1.1 Purpose:

Since AC Test Dusts are no longer available, ISO has chosen alternate test dusts: the ISO (SAE) Test Dusts, as replacements for the AC Test Dusts. In addition, ISO has also instituted a new calibration procedure, ISO 11171, for automatic particle counters (APCs) utilized in filter performance testing and measuring fluid cleanliness levels as a replacement for the previous calibration procedure ISO 4402 (1991) which utilized AC Fine Test Dust. This information report compares and contrasts laboratory filter element performance and fluid cleanliness levels obtained with the new test dusts and ISO 11171 calibration procedure to those obtained with the AC Test Dusts and the previous calibration procedure ISO 4402 (1991).

It should be noted that none of the changes discussed in this report will impact filter element performance or fluid cleanliness in actual service conditions in the field. The changes in test dusts and automatic particle counter calibration will impact laboratory filter element performance specifications and performance requirements therein as well as fluid cleanliness level specifications and requirements set by OEMs and operators.

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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.

2.1 SAE Publications:

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

AIR887	Liquid Filter Ratings, Parameters and Tests
AIR1666	Performance Testing of Lubricant Filter Elements Utilized in Aircraft Power and Propulsion Lubrication Systems Performance Testing of Gas Turbine Lube Oil Filter Elements
ARP1827	Measuring Aircraft Gas Turbine Engine Fine Fuel Filter Element Performance
AIR4246	Contaminants for Aircraft Turbine Engine Fuel System Component Testing
AS4059	Aerospace - Cleanliness Classification for Hydraulic Fluids
ARP598	The Determination of Particulate Contamination in Liquids by the Particle Count Method

2.2 ISO Publications:

Available from International Organization for Standardization, Case Postal 56, CH-1211 Geneva 20, Switzerland.

ISO 4402 (1991)	Hydraulic fluid power – Calibration of automatic-count Instruments for particles suspended in liquids - Method using classified AC Fine Test Dust contaminant
ISO 4406 (1987)	Hydraulic fluid power – Fluids – Method for coding level of contamination by solid particles
ISO 4407	Hydraulic fluid power – Fluid contamination – Determination of particulate contamination by the counting method using a microscope
ISO 11171	Hydraulic fluid power – Calibration of automatic particle counters for liquids
ISO 11218	Aerospace – Cleanliness classification for hydraulic fluids
ISO 12103-1	Road vehicles – Test dust for filter evaluation; Part 1: Arizona test dust
ISO 16889	Hydraulic fluid power filters – Multi-pass method for evaluating filtration performance of a filter element

2.3 Military Specifications:

Available from the DODSSP, Subscription Services Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

MIL-F-8815D	Military Specification – Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems; General Specification For
MIL-E-5007	Engine, Aircraft, Turbojet and Turbofan, General specification For (Inactive For New Design as of January, 1997)

2.4 Aerospace Industries Association (AIA) Publications:

Available from Aerospace Industries Association of America, Inc., 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901.

NAS 1638 Cleanliness Requirements of Parts Used in Hydraulic Systems

2.5 National Institute of Standards and Technology Publications:

Available from National Institute of Standards and Technology, ???

NIST SRM 2806	National Institute of Standards and Technology – Standard Reference Material 2806 – Medium Test Dust (MTD) in Hydraulic Fluid (1997)

3. INTRODUCTION AND BACKGROUND:

AC Fine Test Dust (ACFTD) and AC Coarse Test Dust (ACCTD) are silica based contaminants that are characterized in terms of their chemical composition and particle size distributions. Because of their consistent particle size distributions and irregular particle shapes, believed to be more representative of contaminants found in typical hydraulic, fuel and lube systems, the AC Test Dusts have been utilized for several decades as 'model' test contaminants in laboratory testing of filter element performance and fluid system component contaminant sensitivity testing. They have also been specified as the 'model' contaminant in the majority of filter performance specifications in Aerospace applications.

AC Fine Test Dust was also chosen for the above reasons in 1969-1970 for the development of a calibration procedure for automatic, liquid borne, particle counters whose operation is based on light obscuration. The calibration procedure, ISO 4402:1991, is based on the average longest chord dimension, measured using optical microscopes. The goal of the calibration procedure was to ensure that particle counts obtained with an automatic particle counter (APC) agreed as closely as possible with counts obtained by optical microscopy, the most common method employed to obtain particle counts at that time. This particle size distribution, defined in ISO 4402 (1991), is shown graphically in Figure 1.

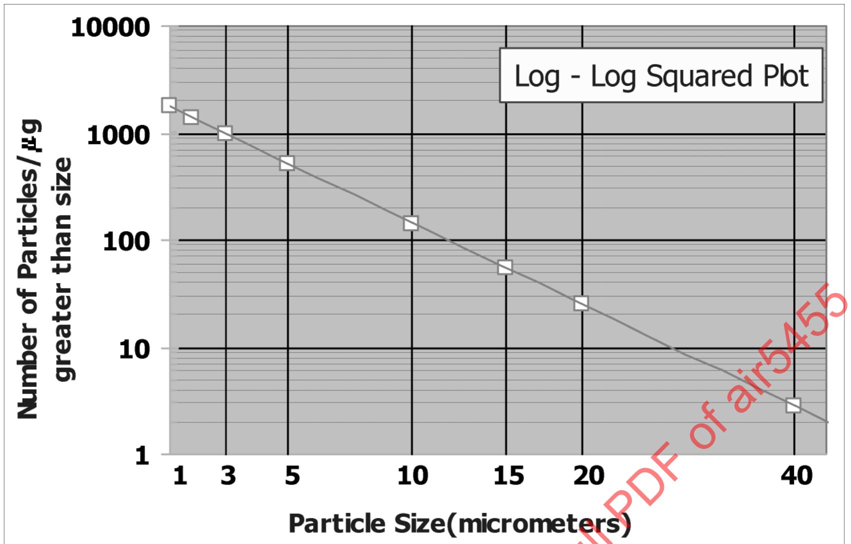

FIGURE 1 - AC Fine Test Dust Size Distribution Based on Longest Chord Dimension

3.1 New Test Contaminants:

Since the AC Test Dusts, which were manufactured by AC Rochester Division, General Motors, are no longer being produced, SAE and ISO have selected related contaminants, specifically the SAE Test Dusts, as replacements. In addition, an Ultrafine test dust has also been included. The four test dusts, referenced in ISO 12103-1, are listed below in Table 1.

TABLE 1 - Replacement Contaminants for AC Test Dusts

ISO Test Dust Designation	Corresponding AC Test Dust	SAE Designation, Other designation(s)*
ISO 12103-A1 (Ultrafine Test Dust; ISO UFTD)	None	None, PTI 0-10 µm Test Dust
ISO 12103-A2 (Fine Test Dust; ISO FTD)	AC Fine Test Dust	SAE Fine Test Dust, PTI Fine Test Dust
ISO 12103-A3 (Medium Test Dust; ISO MTD)	None	SAE 5-80 µm Test Dust, PTI 5-80 µm Test Dust
ISO 12103-A4 (Coarse Test Dust; ISO CTD)	AC Coarse Test Dust	SAE Coarse Test Dust, PTI Coarse Test Dust

* PTI - Powder Technology, Inc.

3.1 (Continued):

The replacement ISO contaminants are processed from the same silica based material that the AC Test Dusts were processed from, but they differ in their particle size distributions. Figure 2 depicts plots of the particle size versus number distribution of the dusts in terms of number of particles in one microgram (1 ml of a 1 mg/L suspension) of dust greater than a given particle size. The particle size distributions reported in Figure 2 are based on measurements with an automatic particle counter calibrated with ACFTD in accordance with ISO 4402:1991 (Figure 1).

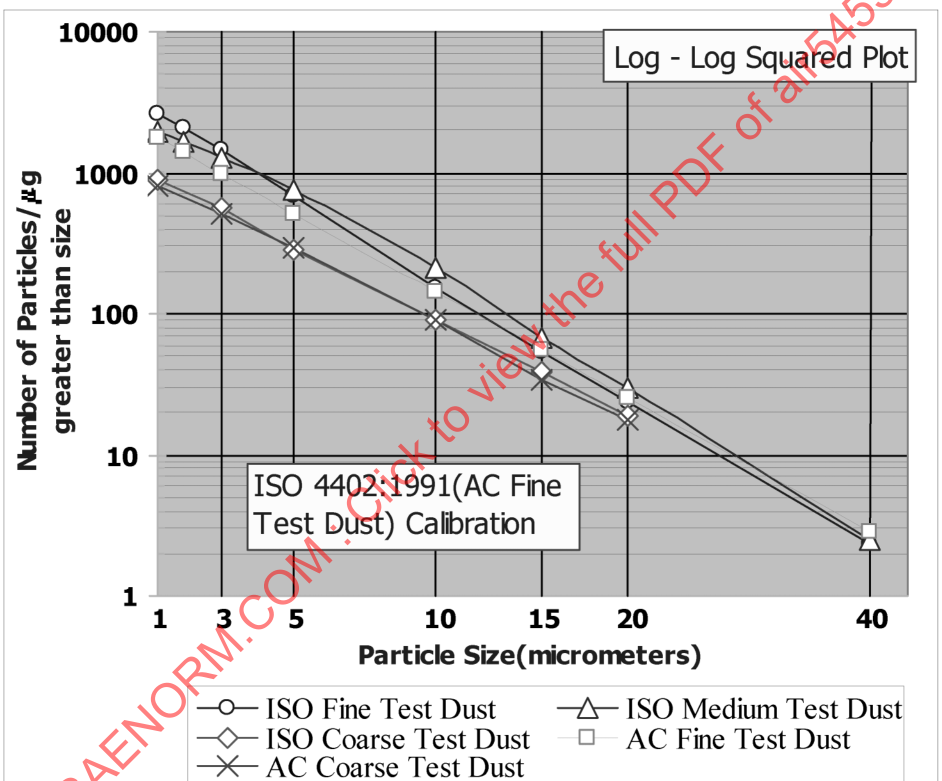

FIGURE 2 - Particle Size Distributions of AC and ISO Test Dusts

Both ISO MTD and ISO FTD exhibit higher particle counts than ACFTD for sizes below about 10 µm. The differences in particle size distributions between the AC and ISO Test Dusts will impact two key filter element performance parameters in laboratory testing: (1) Filtration efficiency, and (2) Dirt capacity.

3.2 Particle Counter Calibration:

The calibration of automatic particle counters (APCs) per ISO 4402:1991 is accomplished by counting a reference calibration sample of AC Fine Test Dust suspended in MIL-H-5606 fluid and adjusting the particle counter thresholds to obtain the appropriate cumulative particle counts/ml (Figure 1) for the required ISO 4402 ACFTD particle sizes.

ISO has developed an APC calibration procedure ISO 11171 to replace ISO 4402 (1991). ISO 11171 employs ISO 12103-A3 Test Dust (ISO MTD) as a replacement for ACFTD. The National Institute of Standards and Technology (NIST) has certified the distribution of ISO MTD via electron microscopy, NIST Standard Reference Material SRM 2806. The results of the NIST analysis, Figure 3, show a significant difference in the particle size distribution of ISO MTD as measured with an electron microscope (NIST) compared to results with an APC calibrated with ACFTD per ISO 4402 (1991). The APC data reported for ISO MTD in Figure 3 are the averages from an international round robin test program sponsored by ISO TC131/SC8/WG9.

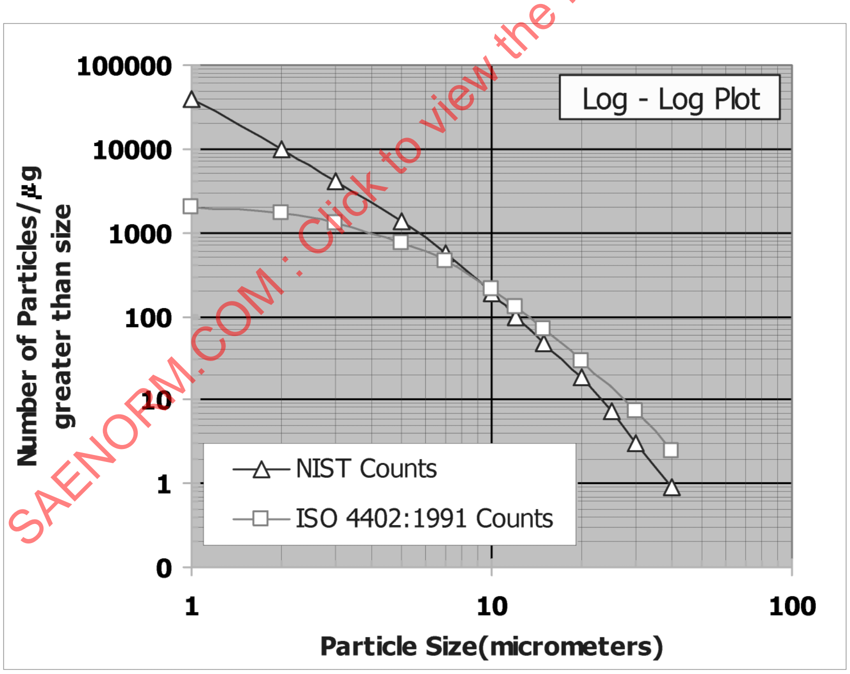

FIGURE 3 - Particle Size Versus Number Distribution of ISO MTD - ISO 4402 Versus NIST

3.2 (Continued):

At particle sizes below ~10 µm, the NIST (ISO 11171) particle size distribution shows significantly higher numbers of particles than the size distribution determined with APCs calibrated per ISO 4402:1991, whereas above a particle size of ~10 µm, the NIST distribution shows fewer counts. Thus, for particle sizes below ~10 µm, the particle size determined by NIST for a given particle count (particles/µg) is greater than the corresponding particle size per ISO 4402:1991; the difference increases with decreasing particle size. As an example, the particle count for 1 µm (ISO 4402:1991 calibration) of about 2000 particles/µg (Figure 3) corresponds to a particle size of 4.2 µm per ISO 11171.

Thus, below ~10 µm, the ISO 11171 definition of the particle size (per NIST size distribution) will be higher than the ISO 4402 definition, e.g., 2 µm (ISO 4402) is 4.6 µm per ISO 11171 and 5 µm (ISO 4402) is 6.4 µm (ISO 11171). Above ~10 µm, the opposite relationship exists in that the ISO 11171 definition of particle size will be lower than the ISO 4402 definition, e.g., 15 µm (ISO 4402) is about 13.6 µm (ISO 11171). The relationship between particle sizes defined by ISO 4402:1991 and ISO 11171 is shown below in Figure 4 and Table 2.

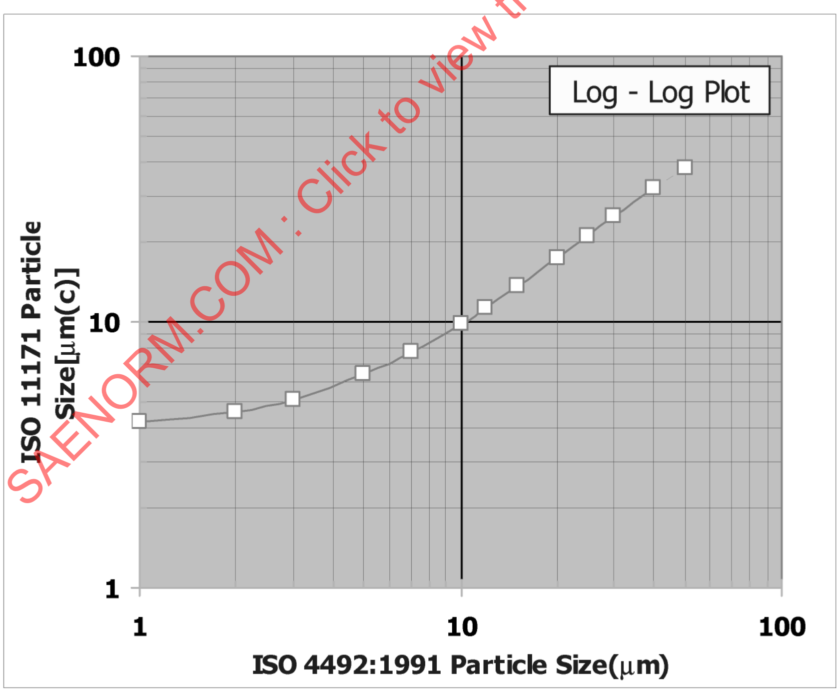

FIGURE 4 - Comparison of ISO 4402:1991 and ISO 11171 Particle Sizes

TABLE 2 - ISO 4402 and ISO 11171 Particle Sizes

ISO 4402:1991 Particle Size(µm):	1	2	3	5	10	15	20	25	40	50
ISO 11171 Particle Size [µm(c)]:	4.2	4.6	5.1	6.4	9.8	13.6	17.5	21.2	31.7	38.4

3.2 (Continued):

In order to distinguish particle sizes defined in ISO 11171 from particle sizes defined per ISO 4402 (1991), the ISO 11171 particle sizes are designated as µm(c) or micrometer(c), the (c) indicating NIST certified sizes. The redefinition of particle sizes with ISO 11171 calibration will have a significant impact on filtration efficiencies since filtration efficiencies attributed to a particle size per ISO 4402:1991 will now correspond, approximately, to the ISO 11171 size in Table 2 (Figure 4). In addition, the redefinition of particle size will also have an impact on the cleanliness classes in cleanliness standards such as NAS 1638, SAE AS4059, ISO 11218, and ISO 4406 which are defined in terms of allowable particle counts for various, specified particles size ranges.

It should be emphasized that the above changes are an artifact of the redefinition of particle sizes, and fluid system cleanliness as well as filtration efficiencies in the field will not be changed due to ISO 11171 calibration. However, filter element particle removal efficiencies, determined in the laboratory, will change due to the change in particle counter calibration.

4. LABORATORY FILTER ELEMENT PERFORMANCE - FILTRATION EFFICIENCY:

Filtration Efficiency is qualified by a variety of standard tests developed over the years for hydraulic, lube, and fuel filter elements. They include:

1. Single Pass Gravimetric Efficiency test, primarily specified for hydraulic filter elements in a variety of military and commercial specifications. The gravimetric efficiency will be impacted by the change in contaminant size distribution: ACFTD versus ISO FTD, as discussed in 4.1.1.

2. Multipass (or Single Pass) Filtration Ratio test (SAE ARP1827, ISO 16889), specified for filter elements used in engine lubrication systems, helicopter transmission lubrication systems, integrated drive generator (IDG) lubrication systems, and fine filter elements used in fuel systems. Filtration Ratios will be impacted by: (a) Change in contaminant size distribution: ACFTD versus ISO FTD, and (b) Change in particle counter calibration from ISO 4402:1991 to ISO 11171, i.e., redefinition of particle sizes. They are discussed in 4.1.2 and 4.1.3.

In addition, the Absolute Rating: Maximum Spherical Particle Passed test, is commonly used to specify filtration ratings for hydraulic and fuel filter elements, and also for some lube filter elements. Since AC Test Dusts or automatic particle counters are not employed in the test, the Absolute Rating will not be affected by the changes.

4.1 Impact of Change in Test Dusts:

4.1.1 Single Pass Gravimetric Efficiency: The single pass gravimetric efficiency test is specified in MIL-F-8815 and in other military and commercial specifications for hydraulic filter elements. The gravimetric efficiency is determined by passing a fixed volume of test fluid, having a known mass of test contaminant suspended in it, through the test filter element and determining the mass of contaminant in the effluent fluid from the filter element. The test contaminant usually is either ACFTD or a mixture of ACFTD and APM F-9 Glass Beads (MIL-F-8815).

The results of determination of gravimetric efficiencies of representative hydraulic filter elements, rated at 5 μm Absolute and 15 μm Absolute, with ACFTD and ISO FTD contaminants have shown that single pass gravimetric efficiencies with ISO FTD contaminant are either comparable to or slightly lower (within 1%) than the corresponding gravimetric efficiencies with ACFTD contaminant.

4.1.2 Multipass Filtration Ratios (Beta Ratios): The impact of change in test dust (ACFTD to ISO FTD) on Beta Ratios is shown in Figure 5 for representative filter elements utilized in Aerospace applications, rated between 3 μm and 30 μm. Filtration Ratios were determined in accordance with the multipass filter performance test procedure in SAE ARP1827; Section 7 - 'Filter Element Efficiency', using ISO 4402:1991 calibration for both test dusts. Beta Ratios with ISO FTD contaminant are lower for particle sizes above 3 μm, and either comparable to or somewhat higher for particle sizes below 3 μm.

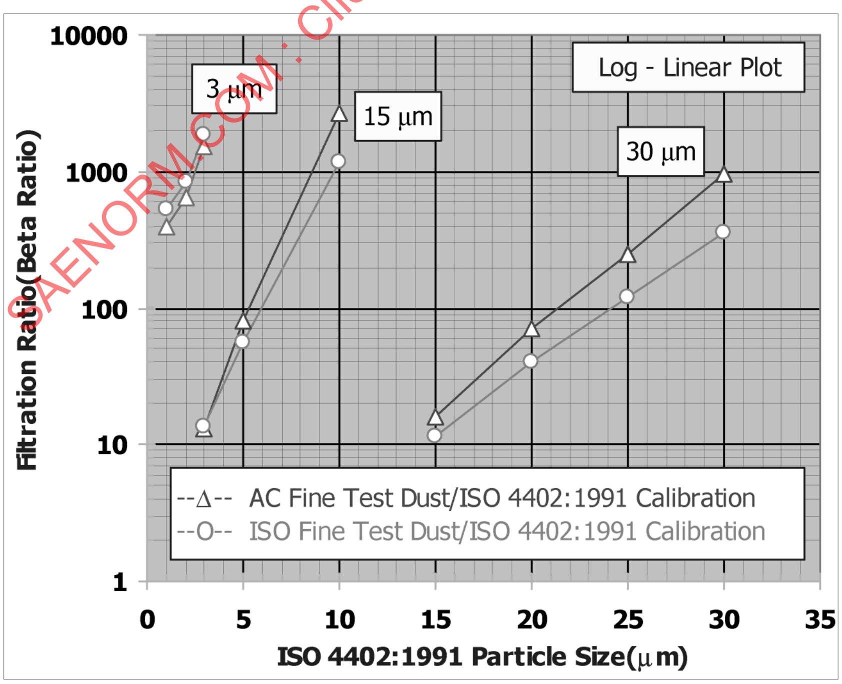

FIGURE 5 - Comparison of Multipass Beta Ratios - ACFTD Versus ISO FTD

4.1.3 Single Pass Filtration Efficiencies (Theta Ratios): For coarse filter elements, rated at greater than 35 µm, Filtration Ratios are determined via a modified form of SAE ARP1827 (Section 7): (1) AC Coarse Test Dust contaminant is utilized, (2) The test is performed in the single pass mode, i.e., with the system clean-up filter in line throughout the test. Filtration Ratios are designated Theta Ratios to distinguish them from Beta Ratios. Figure 6 depicts the results of the testing of several filter elements utilized in Aerospace applications with ACCTD and ISO CTD contaminants, employing ISO 4402:1991 calibration. The results show that Theta Ratios with ISO CTD contaminant are either comparable to, or somewhat lower than, Theta Ratios with ACCTD.

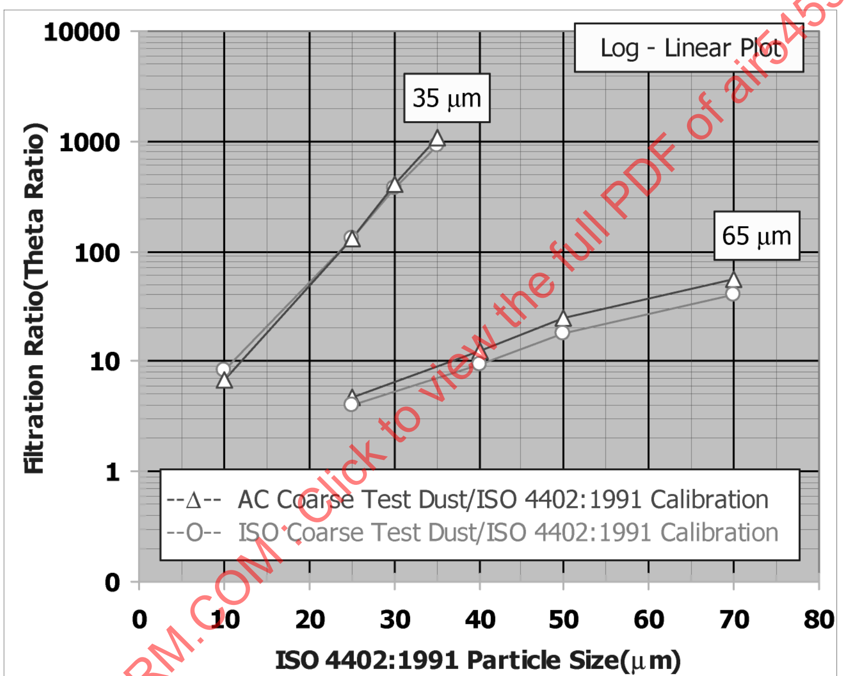

FIGURE 6 - Comparison of Single Pass Theta Ratios - ACCTD Versus ISO CTD

4.2 Impact of ISO 11171 Calibration:

The impact of ISO 11171 calibration (Table 2) is such that filter elements will appear to be coarser below ~10 µm, i.e., lower filtration efficiencies, and somewhat finer (higher filtration efficiencies) above ~10 µm. This is shown in Table 3 for the three filter elements depicted in Figure 5. Particle sizes corresponding to Beta Ratios of 75, 200, and 1000, i.e., particle removal efficiency of 98.6%, 99.5% and 99.9%, respectively, are tabulated, based on the Filtration Ratios depicted in Figure 5 and the particle size relationship between ISO 4402 and ISO 11171 calibrations in Table 2, for ACFTD contaminant/ISO 4402:1991 calibration, ISO FTD contaminant/ISO 4402:1991 calibration, and ISO FTD contaminant/ISO 11171 calibration.

4.2 (Continued):

Figure 7 shows plots of Filtration Ratio versus particle size for the three filter elements in Table 3 for ACFTD contaminant/ISO 4402:1991 calibration and ISO FTD contaminant/ISO 11171 calibration.

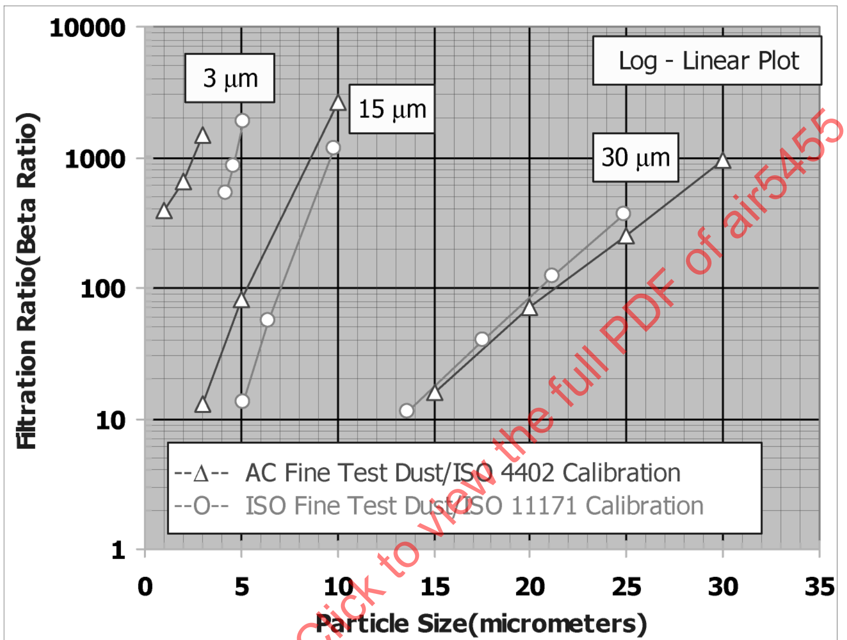

FIGURE 7 - Comparison of Beta Ratios: ACFTD/ISO 4402 Versus ISO FTD/ISO 11171

TABLE 3 - Comparison of Multipass Filtration Ratings

Filtration Rating (Figure 5)	Contaminant:	ACFTD	ISO FTD	ISO FTD
	Calibration:	ISO 4402	ISO 4402	ISO 11171
	Beta Ratio	Particle size corresponding to Beta Ratio		
3 µm	1000	2.5 µm	2.2 µm	4.7 µm(c)
15 µm	75	4.9 µm	5.4 µm	6.7 µm(c)
	200	6.3 µm	7.1 µm	7.8 µm(c)
30 µm	75	20.2 µm	22.8 µm	19.6 µm(c)
	200	24.1 µm	27.3 µm	22.9 µm(c)

4.2 (Continued):

Table 4 summarizes the comparison of single pass Theta Ratios for the two filter elements depicted in Figure 6. Particle sizes corresponding to Theta Ratios of 20, 75, and 200 , i.e., particle removal efficiency of 95%, 98.6%, and 99.5%, respectively, are tabulated, based on the Filtration Ratios depicted in Figure 6 and the particle size relationship between ISO 4402 and ISO 11171 calibrations in Table 2, for ACCTD contaminant/ISO 4402:1991 calibration, ISO CTD contaminant/ISO 4402:1991 calibration, and ISO CTD contaminant/ISO 11171 calibration.

TABLE 4 - Comparison of Single Pass Filtration Ratings (Theta Ratios)

Filtration Rating (Figure 6)	Contaminant:	ACCTD	ISO CTD	ISO CTD
	Calibration:	ISO 4402	ISO 4402	ISO 11171
	Theta Ratio	Particle size corresponding to Theta Ratio		
35 µm	75 200	22.1 µm 26.9 µm	21.9 µm 26.9 µm	18.9 µm(c) 22.6 µm(c)
65 µm	20 75*	46.8 µm 77.0 µm	52.4 µm 85.4 µm	39.9 µm(c) 60.2 µm(c)

* Corresponding particle sizes are extrapolated values.

Figure 8 depicts plots of Filtration Ratio versus particle size for ACCTD contaminant/ISO 4402:1991 calibration and ISO CTD contaminant/ISO 11171 calibration for the two filter elements in Table 4.

As expected, Theta Ratios with ISO CTD contaminant/ISO 11171 calibration are increased in the 10+ µm size ranges compared to ACCTD contaminant/ISO 4402 calibration.

Overall, the results show that finer filter elements, rated below 10 µm, will appear coarser, whereas coarser filter elements, rated above 10 µm, will appear finer when tested with ISO FTD or ISO CTD and ISO 11171 calibration compared to ACFTD or ACCTD and ISO 4402 (1991) calibration. It should be reemphasized that this change is an artifact of changing laboratory test contaminant and calibration procedures, and filter element efficiencies in the field will remain unchanged.

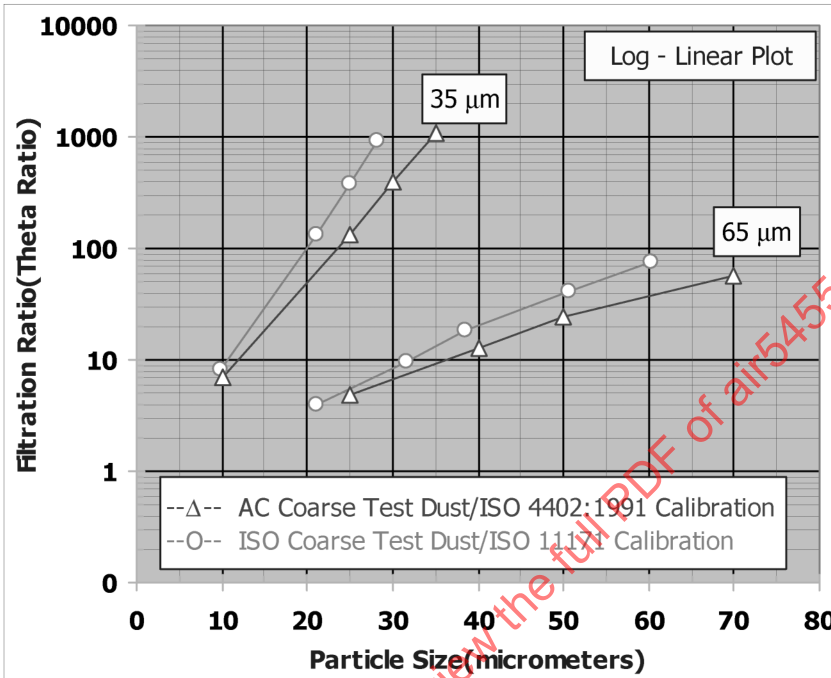

FIGURE 8 - Comparison of Theta Ratios: ACCTD/ISO 4402 Versus ISO CTD/ISO 11171

5. LABORATORY FILTER PERFORMANCE - DIRT CAPACITY:

Principal methods for determining filter element dirt capacity include:

1. 'Slug Load' Dirt Capacity, specified in MIL-F-8815 and other specifications for hydraulic filter elements, and for filter elements used in engine lubrication systems, some helicopter transmission lubrication systems, and Constant Speed Drive (CSD) lubrication systems.

   In the 'Slug Load' dirt capacity test, the test contaminant is introduced upstream of the filter, in the form of discrete slugs of equal mass, at regular intervals of 4 minutes. Filter element differential pressure is monitored 2 minutes after addition of each contaminant slug. The mass of test contaminant added to a predefined filter element differential pressure is defined as the dirt capacity. The 'Slug Load' dirt capacity test may be performed in the multipass (recirculating) mode, as required in MIL-F-8815, or in the single pass mode, i.e., with the system clean-up filter in-line throughout the test.

5. (Continued):

2. Continuous Ingression, Multipass (or Single pass) Dirt Capacity, often specified for helicopter transmission lube filter elements, IDG lube filter elements, and some engine lube filter elements.

   The continuous ingression dirt capacity is determined as part of the Filtration Ratio Test (Multipass or Single pass) described in Section 4. Unlike the 'Slug Load' dirt capacity test, contaminant is ingressed continuously, in slurry form, into the filter element test circuit throughout the test. The mass of test contaminant ingressed to a predefined filter element differential pressure is defined as the dirt capacity.

3. MIL-E-5007 or SAE ARP1827 Dirt Capacity, specified for engine fuel filter elements.

   The dirt capacity test is conducted in jet fuel utilizing contaminant specified in MIL-E-5007; the contaminant includes AC Test Dusts. In some commercial applications, AC Test Dusts are specified as the test contaminant. Typically, the test contaminant is ingressed continuously into the test circuit fuel reservoir via a belt feed system. The dirt capacity is either taken as the mass of test contaminant ingressed to a predefined filter element differential pressure or, often, as the equivalent test time to achieve the predefined filter element differential pressure.

   The dirt capacity could be impacted by the change in particle size distribution: AC Test Dust(s) versus ISO Test Dust(s), as discussed in 5.1.

5.1 Impact of Change in Test Dusts:

5.1.1 'Slug Load' Dirt Capacity: Figure 9 depicts a bar chart showing the percent change in 'Slug Load' dirt capacity with ISO FTD/CTD contaminant compared to ACFTD/ACCTD contaminant for representative filter elements utilized in Aerospace applications. The results indicate a decrease in dirt capacity with ISO FTD or ISO CTD compared to the corresponding ACFTD or ACCTD dirt capacity. The decrease in dirt capacity ranges between ~5% and ~45%, depending on the filtration rating of the filter element, with finer filter elements, rated at 3-20 µm, exhibiting the greatest decrease in dirt capacity with ISO FTD contaminant. The fact that the particle size distribution of ISO FTD is somewhat finer than ACFTD (Figure 2) is likely to contribute to the reduction in ISO FTD dirt capacity.

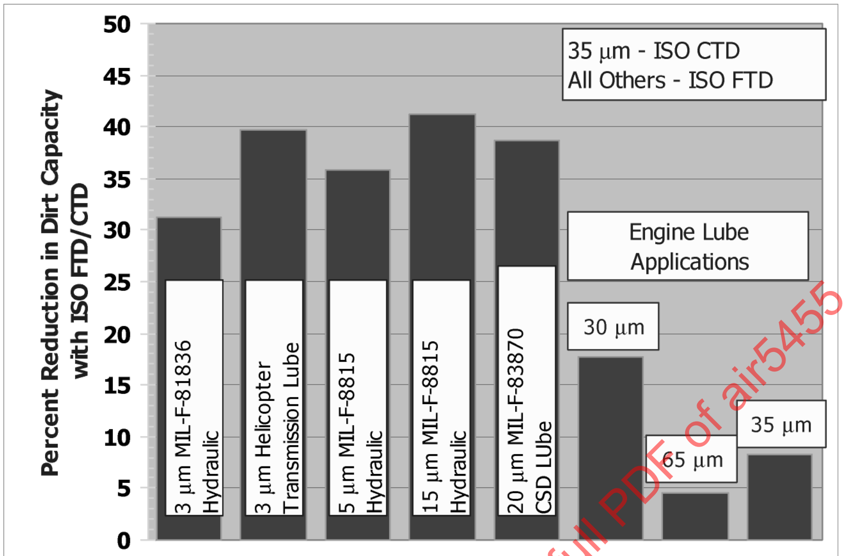

FIGURE 9 - Percent Reduction in 'Slug Load' Dirt Capacity With ISO FTD/CTD Contaminant, Compared to ACFTD/ACCTD Contaminant

5.1.2 Continuous Ingression Dirt Capacity: Figure 10 depicts a bar chart showing the percent change in continuous ingression, Filtration Ratio dirt capacity with ISO FTD/CTD contaminant compared to ACFTD/ACCTD contaminant for filter elements utilized in Aerospace engine and transmission lube applications. In general, the results parallel the results of the 'Slug Load' dirt capacity testing. The dirt capacity with ISO FTD is decreased by as much as ~45% compared to the corresponding ACFTD dirt capacity for fine filter elements rated at 3-20 µm. The decrease in dirt capacity with ISO FTD or ISO CTD is smaller (≤20%) for coarser filter elements, rated at 20-65 µm, with the 35 µm rated filter element (Figure 10) actually showing a small increase of ~7% in ISO FTD dirt capacity.

Overall, the results show that the 'Slug Load' dirt capacity is reduced with ISO FTD and ISO CTD contaminants in fine filter elements, 3-20 µm rated, by as much as ~45%, and in coarser filter elements, 30-65 µm rated, by as much as ~20%. In general, Filtration Ratio test dirt capacities show similar trends. It should be emphasized that the changes in laboratory dirt capacities, discussed above, will not impact actual filter element service life in the field.

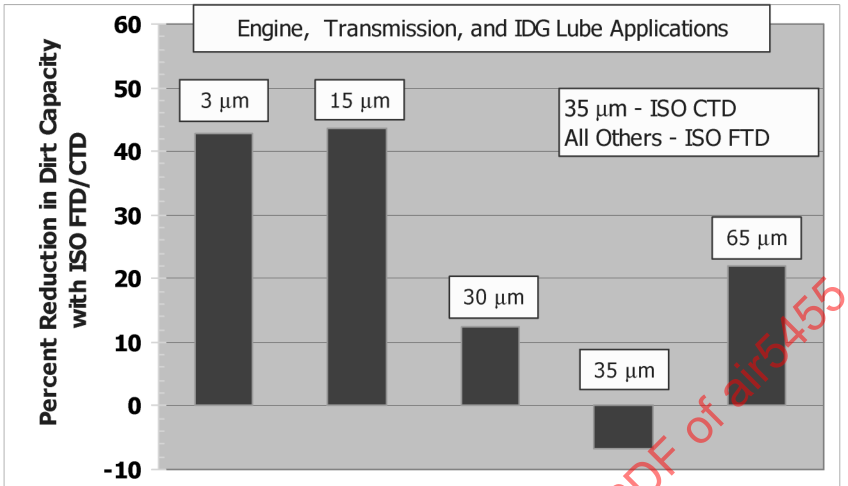

FIGURE 10 - Percent Reduction in Continuous Ingression Dirt Capacity With ISO FTD/CTD Contaminant, Compared to ACFTD/ACCTD Contaminant

5.1.3 MIL-E-5007 and ARP1827 Dirt Capacity: These dirt capacity tests, utilized for fuel filter elements, are conducted in jet fuel or a reference calibration fluid. The contaminant includes varying amounts of iron oxides (Hematite and Magnetite), AC Test Dust (usually AC Coarse Test Dust), crushed quartz, salt water, naphthenic acid, and cotton linters. Under the test conditions, the iron oxides and AC Test Dust agglomerate in the test fuel, especially when salt water is present, to form a 'filter cake' on the filter element. This has a critical influence on the dirt capacity.

In view of the above, the change in size distribution between the AC and ISO Test Dusts would not be expected to have a very significant impact on dirt capacity. This is borne out by test data comparing MIL-E-5007 contaminant containing AC Coarse Test Dust with MIL-E-5007 contaminant containing ISO Coarse Test Dust instead of AC Coarse Test Dust. The difference in average dirt capacity was found to be within 3%, which is less than the accuracy of the test. Another set of dirt capacity tests were performed with a modified form of MIL-E-5007 contaminant, utilized in a commercial engine fuel filter application, in which AC Fine Test Dust is a component of the contaminant. The impact of replacing AC Fine Test Dust with ISO Fine Test Dust was investigated. The difference in average dirt capacity was found to be within 1%, which, again, is less than the accuracy of the test.

Based on the limited testing above, one may conclude that the impact of replacing AC Test Dusts with ISO Test Dusts would not be expected to be significant in the MIL-E-5007 and ARP1827 dirt capacity tests.