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(R) Contaminants for Aircraft Turbine Engine Fuel System Component Testing

RATIONALE

Revision D: (1) Scope rewritten for clarity (editorial), (2) Table 13, GEC contaminant size distribution corrected, (3) Updated description of cotton linters contamination, (4) Carbon fiber contamination description updated to include nominal diameter and length.

1. SCOPE

1.1 Introduction

This SAE Aerospace Information Report (AIR) is intended as a guide toward standardization of descriptions and specifications of fluid contamination products.

1.2 Scope and Field of Application

This document discusses descriptions of fluid contamination products. These contaminants are used for design evaluation and formal component qualification/certification testing. Such tests are routinely performed on candidate aircraft engine fuel and pneumatic system components. Typical of these components are fuel pumps, fuel filters, fuel controls, pressurizing valves, flow dividers, selector valves, and combustor nozzles. The purpose of this document is to recommend standard descriptions to be used by specification writers.

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 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.

MAP749 Aircraft Turbine Engine Fuel System Component Endurance Test Procedure (Room Temperature Contaminated Fuel)

ARP1827 Measuring Aircraft Gas Turbine Engine Fine Fuel Filter Element Performance

ARP4014 Aircraft Turbine Engine Pneumatic Component Contaminated Air Endurance Test

AIR4023 Aircraft Turbine Fuel Contamination History and Endurance Test Requirements

J726 Air Cleaner Test Code

2.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-E-5007[1] Engines, Aircraft, Turbojet and Turbofan, General Specification for

MIL-E-8593[2] Engines, Aircraft, Turboshaft and Turboprop, General Specification for

MIL-PRF-87260B Foam Material, Explosion Suppression, Inherently Electrostatically Conductive, For Aircraft Fuel Tanks

JSSG-2007 Joint Service Specification Guide Engines, Aircraft, Turbine

JSSG-2009 Joint Service Specification Guide Air Vehicles Subsystems

2.2.1 ISO Publications

Available from International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41-22-749-01-11, www.iso.org.

ISO 12103-1 Road vehicles - Test dust for filter evaluation - Part 1: Arizona test dust

2.3 Other References

a. The Impact of Copper on the Liquid-Phase Oxidation of Jet Fuel for Advanced Aircraft, Robert E. Morris, Janet M. Hughes, and, John E. Colbert, Energy & Fuels, 2004 18 (2), pp. 490-496.

b. Hazlett, R. N. Thermal Oxidation Stability of Aviation Turbine Fuels, ASTM: Philadelphia, 1991

c. Additive Depletion and Thermal Stability Degradation of JP-5 Fuel Shipboard Samples, J. P. Cueller, Jr., J. A. Russell, Southwest Research Institute (SWRI), Report NAPC-PE-141C, 1985.

[1] MIL-E-5007 (all revisions) is inactive for new design as of January, 1997.
[2] MIL-E-8593 is inactive for all new design and is no longer used, except for replacement purposes, effective January, 1997.

3. CONSIDERATIONS IN SPECIFYING TEST CONTAMINANTS

Particle Size Distributions: Two common methods are used to describe particle size distributions. These are the "differential range" and ’cumulative scale" methods.

a. Differential Range: This method involves expressing particle counts for discrete size ranges with an acceptable deviation within each discreet size range A typical example of a "differential range" description is shown in Table 1. This distribution has been used to specify SAE J726 Fine Test Dust.

TABLE 1 - DIFFERENTIAL PARTICLE SIZE DISTRIBUTION

Particle Size (µm)	Percent of Total (by weight)
0 - 5	39 ± 2
5-10	18 ± 3
10-20	16 ± 3
20-40	18 ± 3
40-80	9 ± 3

b. Cumulative Scale: This method involves listing cumulative particle counts for particles equal to or larger than specified particle sizes along the desired distribution curve and the acceptable deviation at each point.. An example is shown in Table 2. This description has been used to specify SAE J726 Fine Test Dust.

TABLE 2 - CUMULATIVE DISTRIBUTION CURVE

Particle Size (µm)	Percent of Total Greater Than Stated Size (by weight)
5	61 ± 2
10	43 ± 3
20	27 ± 3
40	9 ± 3
80	0

Cumulative scale descriptions are typically used for broad particle size distributions such as the Silica based ISO Test Dusts in ISO 12103-1 with size distributions in the 0 to 200 µm size range. Differential range descriptions are typically used when it is necessary to specify a specific size range. As an example if it is required to determine the specific size range that causes gear wear in a pump, a series of contamination sensitivity tests would be run with various differential ranges of contaminant to identify the size range corresponding to the maximum contaminant sensitivity.

It should be noted that the accumulation of errors could be very different in differential and cumulative size distributions, depending on how the contaminant was processed to arrive at the distribution, and users must take this into consideration in deciding on which distribution mode to specify.

Specification of test contaminants: Descriptions should be carefully considered before making them part of a specification. Prior history and current production capabilities should be investigated when specifying contaminant descriptions. History sets precedence as it is often necessary to compare new aircraft hardware performance with that of the past. Test contaminants should ultimately be designed to simulate actual contaminant products seen in the field. Using modern techniques, field contaminants can usually be duplicated as test contaminants. Surveys of actual in-field contaminants have led to the definition of standard fuel system test contaminants.

For aircraft made of conventional materials (e.g., aluminum), Table X of MIL-E-5007E has been developed. It is worth noting that the large quartz (420 to 1500 µm) is included to cover the aluminum chips generated from the manufacture and repair of aluminum tanks.

Carbon Fiber Contamination: The use of carbon fiber/graphite composite materials in new aircraft and fuel system designs or in major modifications/repair may result in fuel system contamination with carbon fiber/graphite composite debris. Thus it should be considered for verification testing of any fuel system. Two types of carbon based composite contaminants are defined in the list of standard contaminants in Appendix A: Carbon fiber rods (Table A12) and Graphite Epoxy Composite (GEC; Table A13). Table C1 in Appendix C has been developed to cover aircraft employing carbon fiber/graphite composite materials in their construction. A newly defined carbon fiber test contaminant, similar to Table C1, was added to the conventional contaminant of Table X of MIL-E-5007E. The concentrations of the conventional components are scaled down so that when the carbon fiber contaminant is included, the overall concentration of contaminant is unchanged.

ISO Test Dusts: The definition of Arizona Test Dust used up to Revision A of this document was as for that manufactured by the AC Spark Plug Company. Replacement test dusts for the AC Test Dusts, no longer available, have been specified by ISO (ISO 12103-1). The corresponding ISO Test Dusts for Arizona Fine and Coarse Test Dusts are, respectively, ISO Fine Test Dust (designated ISO 12103-A2) and ISO Coarse Test Dust (designated ISO 12103-A4). Consequently, the ISO 12103-1 standard has been adopted in this revision to replace the previous standard. It should be noted that the change to ISO Test Dusts could result in test results that differ from those with the corresponding Arizona Test Dusts. It is necessary for users to take this into account when comparing historic test data with data generated with the ISO Test Dusts and when comparing test results with ISO Test Dusts to historic specification requirements with AC Test Dusts.

Cotton Linters Standard: The Cotton Linters contaminant specification was based on the U.S. Department of Agriculture (U.S.D.A.) Standards SRA-AMS 180 and 251. The U.S. Department of Agriculture no longer maintains these standards for the Cotton Linters contaminant. The material is available from vendors who have historically supplied it for fuel testing. The description of the Cotton Linters contaminant has been modified, in consultation with a primary vendor, to be suitable for use in specifications. Exisiting suppliers may be contacted for additional information.

Explosion Suppresant Foam: Explosion Suppresant Foam (ESF) specificed per MIL-PRF-87260B (Foam Material, Explosion Suppression, Inherently Electrostatically Conductive, For Aircraft Fuel Tanks) is being used in both transport and tactical aircraft to address safety hazards associated with static, power, and lightning electrical discharge inside of fuel systems. This foam represents a unique contamination threat to bearings, hinges, pilot holes and other small flow passages which is not simulated by any of the historical contaminants.

Copper Contamination: Copper contamination in aviation fuel has been an area of concern for over 40 years. The presence of dissolved copper, even at trace concentrations of 35 ppb (parts per billion), has been shown to degrade an aviation fuel's Thermal Stability as determined by the ASTM Test Method D3241. Thermal Stability, as measured by ASTM D3241, is a MIL-DTL-5624 specification requirement for JP-5 fuel. Numerous studies have been performed over the past 40 years showing the deleterious effects of trace chemical elements, including copper, on aviation fuel thermal stability. Several technical references are included in 2.4 that summarize the effects of copper on jet fuel thermal stability. Results from Navy shipboard JP-5 fuel sample testing show an average dissolved copper concentration of 250 ppb. Requirements to adequately verify the effect of dissolved copper in engine fuel systems and fuel wetted components have been added to JSSG-2007 tables XXVa, XXVb, and XXVc, and included in Tables C1 & C2 of Appendix C.

4. RECOMMENDED DEFINITIONS OF STANDARD CONTAMINANTS

Appendix A contains recommended descriptions of several contaminants used for current product evaluation in the industry. Some of these descriptions may not have been used previously but should adequately describe particle size distribution of products currently produced by several suppliers. The Arizona test dust definition was changed at Revision C of the AIR to cater for the non-availability of AC test dusts. The new definition is taken from ISO 12103-1.

5. RECOMMENDED COMPOSITION OF CONTAMINANTS FOR FUEL SYSTEM TESTING

Appendix B contains Table X, the fuel contamination requirements from MIL-E-5007E but modified to include ISO Test Dust defined in ISO 12103-1 in place of the original Arizona Test Dust.

Appendix C shows a modified version of the above Table X, designated Table C1, deemed suitable for contaminanted fuel testing of fuel systems fitted to aircraft employing carbon fiber composite materials in the construction of their fuel tanks. Appendix C also shows a test contaminant suitable for continuous operation testing, Table C2.

Appendix D shows the proposed contaminant requirements for the JSSG-2009 specification (Appendix E of the JSSG-2009 specification). The contaminant requirements in Appendix E of the JSSG-2009 specification (at the time of publication of this AIR), have been modified in Appendix D to: (1) include ISO Test Dust defined in ISO 12103-1 in place of the original Arizona Test Dust, (2) include the size distributions of Graphite Epoxy Contaminant (GEC) and Explosion Suppressant Foam (ESF) contaminant, and (3) reduce the concentration of ESF specified in JSSG-2009 .specifcation (at the time of this publication).

6. HISTORICAL INFORMATION

Appendix E shows the original definition of AC produced Fine and Coarse Arizona test dusts which are no longer produced.

Appendix F shows the original MIL-E-5007E Table X including AC Arizona Test Dust which is no longer produced.

Appendix G shows the original JSSG – 2009, Appendix E contaminant table (at the time of the release of this document), specifying AC Arizona Test Dust (which is no longer produced) and including Graphite Epoxy Composite (GEC) and Explosion Suppressant Foam (ESF) contaminants, but without their size distributions. Note also that the concentration of ESF is higher than that proposed in Appendix D.

7. NOTES

7.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE SUBCOMMITTEE AE-5B, ENGINE RELATED COMPONENTS AND AIRFRAME MOUNTED PUMPS OF COMMITTEE AE-5, AEROSPACE FUEL, OIL, AND OXIDIZER SYSTEMS

APPENDIX A

A.1 STANDARDIZED ISO SPECIFIED ARIZONA TEST DUST CONTAMINANT - SPECIFIED IN ISO 12103-1 (GRADES FINE AND COARSE)

TABLE A1 - TYPICAL CHEMICAL ANALYSIS

Chemical	Mass Fraction %
Silicon expressed as SiO_2	68-76
Aluminium expressed as Al_2O_3	10-15
Iron expressed as Fe_2O_3	2-5
Sodium expressed as Na_2O	2-4
Calcium expressed as CaO	2-5
Magnesium expressed as MgO	1-2
Titanium expressed as TiO_2	0.5-1
Potassium expressed as K_2O	0.10
Organics lost from ignition	2-5

TABLE A2 - PARTICLE SIZE DISTRIBUTION

Particle Size (Micrometers)	Maximum Volume Fraction (%) Less Than Indicated Particle Size Fine Grade (ISO 12103-A2)	Maximum Volume Fraction (%) Less Than Indicated Particle Size Coarse Grade (ISO 12103-A4)
1	2.5 to 3.5	0.6 to 1
2	10.5 to 12.5	2.2 to 3.7
3	18.5 to 22	4.2 to 6
4	25.5 to 29.5	6.2 to 8.2
5	31 to 36	8 to 10.5
7	41 to 46	12 to 14.5
10	50 to 54	17 to 22
20	70 to 74	32 to 36
40	88 to 91	57 to 61
80	99.5 to 100	87.5 to 89.5
120	100	97 to 98
180	-	99.5 to 100
200	-	100

A.2 IRON OXIDE FRACTIONS

TABLE A3 - 0 TO SPECIFIED SIZE

Size Range (micrometers)	Acceptable Size Limits
0-5 0-10	Specified fractions shall contain a minimum of 96% within stated size range as measured by volume %. 25 to 35% by volume shall be greater than one half of the specified top size

TABLE A4 - INTERMEDIATE GRADES

Size Range (micrometers)	Acceptable Size Limits
5-10 10-20	Intermediate grade fractions shall contain a minimum of 90% within stated size range as measured by volume %

A.3 COTTON LINTERS

TABLE A5 - SPECIFICATION OF COTTON LINTERS

Type:	Short fibers removed from the cotton seed in a second cut process and ground in a #4 Wiley Mill fitted with a 4 mm screen. Note: Second Cut Cotton Linters have a propensity for agglomoration and clumping, and therefore must be milled to separate the fibers.

NOTE: The U.S. Department of Agriculture no longer maintains the grading standards for Cotton Linters. Until a replacement standard is available, exisiting suppliers should be contacted for specific information.

A.4 GRADED CRUSHED QUARTZ FRACTIONS

TABLE A6 - FROM GOOD COMMERCIAL QUALITY STOCK

Graded Size (micrometers)	U.S. Standard Test Sieve No.
150-300	100-50
300-420	50-40
420-1000	40-18
1000-1500	18-14
NOTE: Fractions shall contain a minimum of 96% within stated size range as measured by weight %.	

A.5 CRUSHED QUARTZ

TABLE A7 - GOOD COMMERCIAL QUALITY

(Micrometers)	% of Total Less Than (by weight)
1000	100
900	98-99
600	93-97
400	82-86
200	46-50
125	18-22
75	3-7

A.6 IRON CHIPS OR FILINGS

TABLE A8 - 0-SPECIFIED SIZE

Graded Size (micrometers)	U.S. Standard Test Sieve No.
0-150	100
NOTE: 99% minimum by weight within stated size.	

TABLE A9 - INTERMEDIATE GRADES

Particle Size (micrometers)	U.S. Standard Test Sieve No.
150-500	100-35
NOTE: 99% minimum by weight within stated size.	

A.7 ALUMINUM CHIPS OR FILINGS

TABLE A10 - 0-SPECIFIED SIZE

Particle Size (micrometers)	U.S. Standard Test Sieve No.
0-150	100
NOTE: 99% minimum by weight within stated size.	

TABLE A11 - INTERMEDIATE GRADES

Particle Size (micrometers)	U.S. Standard Test Sieve No.
150-500	100-35
NOTE: 99% minimum by weight within stated size.	

A.8 CARBON FIBER RODS CONTAMINANT

TABLE A12 - POPULATION DISTRIBUTION

Paricle Size (micrometers)	% (Population)
0-25	43 ± 5
25-50	25 ± 5
50-75	13 ± 5
75-125	12 ± 5
>125	7 ± 5
5.59 GPa nominal tensile strength 5 µm nominal diameter 0 to 2000 µm in length. Maximum fiber length: 2000 µm	

A.9 GRAPHITE EPOXY COMPOSITE (GEC) CONTAMINANT

TABLE A13 - SIZE DISTRIBUTION

Paricle Size (micrometers)	% (Population)
0 - 45	23
45 - 150	26
150 - 300	8
300 - 425	32
425 - 710	11

A.10 EXPLOSION SUPPRESSENT FOAM (ESF) CONTAMINANT

TABLE A14 - DISTRIBUTION

Explosion suppressant Foam (ESF) contaminant is defined as foam in compliance with MIL-PRF-87260B	1 to 100 µm Distribution is random, utilizing method outlined and cut utilizing the methods in 4.2.4 of MIL-PRF-87260B, excluding a hot wire cutter.

APPENDIX B

TABLE B1 - MIL-E-5007E TABLE X - FUEL CONTAMINANTS FOR EQUIVALENT MISSION TIME MODIFIED FOR ISO SPECIFIED ARIZONA TEST DUST

Contaminant	Particle Size	Quantity
Ferroso-Ferric Iron Oxide (Fe_3O_4) (Black color) (Magnetite) Ferric Iron Oxide (Fe_2O_3, Hematite) Ferric Iron Oxide (Fe_2O_3, Hematite)	0 to 5 µm 0 to 5 µm 5 to 10 µm	1.5 g/1000 gal 27.0 g/1000 gal 1.5 g/1000 gal
Crushed Quartz Crushed quartz Crushed Quartz Crushed Quartz	1000 to 1500 µm 420 to 1000 µm 300 to 420 µm 150 to 300 µm	0.25 g/1000 gal 1.75 g/1000 gal 1.0 g/1000 gal 1.0 g/1000 gal
Prepared dirt conforming to ISO 12103-A4 (ISO Coarse Test Dust)	Mixture as follows 0 to 5 µm (9.25%) 5 to 10 µm (10.25%) 10 to 20 µm (14.5%) 20 to 40 µm (25%) 40 to 80 µm (29.5%) 80 to 200 µm (11.5%)	8.0 g/1000 gal
Cotton linters (See footnote 1)	Short fibers removed from the cotton seed in a second cut process and ground in a #4 Wiley Mill fitted with a 4 mm screen.	0.1 g/1000 gal
Crude Naphthenic Acid		0.03% by volume
Salt water prepared by dissolving salt in distilled water or other water containing not more than 200 ppm of total solids	4 parts by weight NaCl 96 parts by weight H_2O	0.01% by volume entrained

NOTE 1: The U.S. Department of Agriculture (USDA) no longer maintains the Grading Standards for Cotton Linters. See Table A5 for current specifcation of Cotton linters

APPENDIX C

TABLE C1 - FUEL CONTAMINANTS FOR EQUIVALENT MISSION TIME
(FOR CARBON FIBER COMPOSITE MATERIAL AIRCRAFT)

Contaminant	Particle Size	Quantity
Ferroso-Ferric Iron Oxide (Fe_3O_4) (Black color) (Magnetite) Ferric Iron Oxide (Fe_2O_3, Hematite) Ferric Iron Oxide (Fe_2O_3, Hematite)	0 to 5 µm 0 to 5 µm 5 to 10 µm	1.43 g/1000 gal 25.66 g/1000 gal 1.43 g/1000 gal
Crushed Quartz Crushed Quartz Crushed Quartz Crushed Quartz	1000 to 1500 µm 420 to 1000 µm 300 to 420 µm 150 to 300 µm	0.24 g/1000 gal 1.66 g/1000 gal 0.95 g/1000 gal 0.95 g/1000 gal
Prepared dirt conforming to ISO 12103-A4 (ISO Coarse Test Dust)	Mixture as follows 0 to 5 µm (9.25%) 5 to 10 µm (10.25%) 10 to 20 µm (14.5%) 20 to 40 µm (25%) 40 to 80 µm (29.5%) 80 to 200 µm (11.5%)	7.60 g/1000 gal
Cotton linters (See footnote1)	Short fibers removed from the cotton seed in a second cut process and ground in a #4 Wiley Mill fitted with a 4 mm screen.	0.1 g/1000 gal
Crude Naphthenic Acid		0.03% by volume
Salt water prepared by dissolving salt in distilled water or other water containing not more than 200 ppm of total solids	4 parts by weight NaCl 96 parts by weight H_2O	0.01% by volume entrained
Graphite Epoxy Composite (GEC)	0 - 45 (23%) Microns 45 - 150 (26%) 150 - 300 (8%) 300 - 425 (32%) 425 - 710 (11%)	1.3 g/1000 US gal
Carbon fiber rods of tensile strength 5.59 GPa nominal	5 µm nominal diameter, 0 to 2000 µm in length. Population distribution: 0 to 25 µm (43% ± 5%) 25 to 50 µm (25% ± 5%) 50 to 75 µm (13% ± 5%) 75 to 125 µm (12% ± 5%) >125 µm (7% ± 5%) Maximum fiber length - 2000 µm	2.05 g/1000 US gal
Copper (footnote 2)	Dissolved	250 ppb minimum

NOTE 1: The U.S. Department of Agriculture (USDA) no longer maintains the Grading Standards for Cotton Linters. See Table A5 for current specifcation of Cotton linters

NOTE 2: Recommended for aircraft required to operate from aboard naval aircraft carriers

TABLE C2 - FUEL CONTAMINANTS FOR CONTINUOUS OPERATION
(BASED ON MIL-E-5007E TABLE X)

Contaminant	Particle Size	Quantity
Ferroso-Ferric Iron Oxide (Fe_3O_4) (Black color) (Magnetite) Ferric Iron Oxide (Fe_2O_3, Hematite) Ferric Iron Oxide (Fe_2O_3, Hematite)	0 to 5 µm 0 to 5 µm 5 to 10 µm	1.0 g/1000 gal 5.0 g/1000 gal 1.0 g/1000 gal
Prepared dirt conforming to ISO 12103-A4 (ISO Coarse Test Dust)	Mixture as follows 0 to 5 µm (9.25%) 5 to 10 µm (10.25%) 10 to 20 µm (14.5%) 20 to 40 µm (25%) 40 to 80 µm (29.5%) 80 to 200 µm (11.5%)	2.0 g/1000 gal
Cotton linters (See footnote 1)	Short fibers removed from the cotton seed in a second cut process and ground in a #4 Wiley Mill fitted with a 4 mm screen.	0.02 g/1000 gal
Copper (footnote 2)	Dissolved	250 ppb minimum

NOTE 1: The U.S. Department of Agriculture (USDA) no longer maintains the Grading Standards for Cotton Linters. See Table A5 for current specifcation of Cotton linters

NOTE 2: Recommended for aircraft required to operate from aboard naval aircraft carriers

APPENDIX D

TABLE D1 - PROPOSED CONTAMINANT MIXTURE IN JSSG-2009, APPENDIX E

Contaminant Mixture		
Contaminant	Particle Size (Microns) [footnote 1]	Quantity (grams per 1000 L)
Iron Oxide	0 - 5 5 - 10	19 1.0
Sharp Silica Sand	150 - 300 300 - 420	0.7 0.7
Prepared dirt conforming to ISO 12103-A4 (ISO Coarse Test Dust)	Mixture as follows 0 to 5 µm (9.25%) 5 to 10 µm (10.25%) 10 to 20 µm (14.5%) 20 to 40 µm (25%) 40 to 80 µm (29.5%) 80 to 200 µm (11.5%)	5.3
Cotton linters (See footnote 2)	Short fibers removed from the cotton seed in a second cut process and ground in a #4 Wiley Mill fitted with a 4 mm screen.	0.07
Iron Chips Aluminum Chips	150 - 500 150 - 500	10 10
Graphite Epoxy Composite	0 - 45 (23%) 45 - 150 (26%) 150 - 300 (8%) 300 - 425 (32%) 425 - 710 (11%)	5.2
Explosion suppressant Foam (ESF) particles. ESF contaminant is defined as foam in compliance with MIL-PRF-87260B (footnote 3)	1 - 100 Distribution is random utilizing method outlined and cut utilizing the methods in 4.2.4 of MIL-PRF-87260B, excluding a hot wire cutter.	0.75

NOTE 1: The contamination used for testing is graded by the sieve method with the exception of ISO Coarse Test Dust, where the particle size distribution is by volume and was determined with a Coulter Counter. In the sieve method, particles considerably larger than 500 microns size could pass through the sieve. Particles in the 700 to 800 micron range have been found in certified test contamination samples.

NOTE 2: The U.S. Department of Agriculture (USDA) no longer maintains the Grading Standards for Cotton Linters. See Table A5 for current specifcation of Cotton linters

NOTE 3: For air vehicle with fuel tank explosion suppression foam installed in the tanks, or which has aerial refueling capability.