Designation: ~~D6986 – 03 (Reapproved 2010)~~ D6986 – 03 (Reapproved 2016)

North American National Standard

Standard Test Method for Free Water, Particulate and Other Contamination in Aviation Fuels (Visual Inspection Procedures)[1]

This standard is issued under the fixed designation D6986; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Fuel quality is paramount in aviation fuels because of their critical application. Many successive types of inspections are conducted to ensure quality protection. Rapid, visual inspections carried out at various locations in the fuel supply system are a critical part of the inspection program. Experience has shown that subjective evaluations such as described by this test method form an effective field alert system that is backed by other, more quantitative tests.

The present test method duplicates much of Test Method D4176, a test method applicable to all distillate fuels. However, the present test method also includes field methods applicable especially to aviation fuels, and is therefore published as a separate test method.

1. Scope

1.1 This test method covers two procedures for establishing the presence of suspended free water, solid particulate, and other contaminants in aviation gasoline and aviation turbine fuels.

1.1.1 Both procedures are intended primarily for use as field tests with the fuel at handling temperature.

1.1.2 Procedure A uses transparent sample containers; Procedure B uses opaque containers.

1.2 Both procedures are rapid methods for contamination detection and include ratings of haze appearance and particulate presence.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2276 Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling

D3240 Test Method for Undissolved Water In Aviation Turbine Fuels

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4176 Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

D5452 Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration

2.2 *ASTM Adjuncts:*

ADJD417601 Distillate Fuel Bar Chart[3]

ADJD417602 Distillate Fuel Haze Rating Standard[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *aviation fuels—as used in this standard*, the term includes both aviation gasoline and aviation turbine fuels.

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum ~~Products~~ Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0 on Aviation Fuels.

Current edition approved ~~July 1, 2010~~Oct. 1, 2016. Published ~~October 2010~~November 2016. Originally published in 2003. Last previous ~~editon~~edition approved in ~~2003~~2010 as ~~D6986~~D6986 – 03 (2010).~~–03.~~ DOI: ~~10.1520/D6986-03R10.~~10.1520/D6986-03R16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from ASTM International Headquarters. Order Adjunct No. ADJD417601.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJD417602.

3.1.2 *clear and bright*—a condition in which the fuel contains no visible water drops or particulates and is free of haze or cloudiness.

3.1.3 *free water*—water in excess to that soluble in the fuel at the temperature of the test and may appear in the fuel as a haze, cloudiness, droplets, or water layer.

3.1.4 *solid particulates*—small solid or semi-solid particles, sometimes referred to as silt or sediment, present in a fuel as the result of contamination by airborne dusts, corrosion by-products, or wear products.

4. Summary of Test Method

4.1 The test method describes two types of sampling containers for evaluating the appearance of aviation fuel samples. Procedure A covers transparent sample containers, including the open jar and the closed circuit sampler, while Procedure B uses opaque containers such as the white bucket.

4.2 In the open jar procedure, a minimum of ~~750 mL (24 oz)~~ 750 mL (24 oz) of fuel is placed into a clear one litre ~~(1 qt)~~ (1 qt) container and examined visually. The jar is then closed and the sample is swirled and examined for visual sediment and water at the bottom of the vortex. Additionally, fuel clarity may be rated by placing a standard bar chart behind the sample and comparing its visual appearance with the standard haze rating photographs. The presence or absence of free water and of particulates is reported.

4.3 In the closed circuit sampler procedure, approximately ~~3500 mL (0.9 U.S.~~ 3500 mL (0.9 U.S. gal) of fuel is placed into the sampler and is examined for clarity and for visual sediment or water droplets on the bottom of the sampler. Additionally, fuel clarity may be rated by placing a standard bar chart behind the sample and comparing its visual appearance with the standard haze rating photographs. The presence or absence of free water and of particulates is reported.

4.4 In the white bucket procedure fuel to a depth of approximately ~~15 cm (6 in.)~~ 15 cm (6 in.) is collected in a white porcelain coated or stainless steel bucket. The sample is examined for solids or sediment, or both, on the bottom of the bucket. Sample clarity can be checked by the appearance of a small, shiny coin on the bucket's bottom. If the fuel is dry, the raised letters on the coin should be easily readable. The amount of sediment can be described by a letter category using a rating guide.

4.5 In both procedures, the sample is inspected for color or other unusual appearance.

4.6 Field inspection procedures are performed immediately after sampling at fuel handling temperature conditions.

5. Significance and Use

5.1 The two procedures in the test method provide rapid methods for field detection of free water and solid contaminants, or any other visually apparent contamination. Uncertain or marginal results by either of these methods would normally result in the performance of methods such as D2276, D5452, or D3240 for quantitative determination of contaminants.

5.1.1 Particulate determination in appearance tests is sensitive to sampling procedures. The presence of a small number of particles may indicate, for example, that the sample line was not flushed to provide a representative sample. The persistent presence of even a small number of particles, however, may be cause for further investigation depending on the situation.

5.2 Experience has shown that an experienced tester using a clear bottle can detect as little as ~~40 ppm~~ 40 ppm of free, suspended water in the fuel. Thus, a fuel rated as *clear and bright* can still fail lower limits set by quantitative methods. A rater will also have difficulty resolving particles smaller than 40 µm. Smaller particles must be determined by other than visual methods such as D2276, D5452 or chemical field tests listed in Manual 5.[5]

5.3 Experience has shown the visual appearance of fuel in a white porcelain bucket to be the most suitable method for the detection of dye contamination or other unusual discoloration. In the U. S., the white porcelain bucket is used to detect the dye.

6. Apparatus

6.1 *Cylindrical Clear Container,* such as:

6.1.1 *Clear Container,* with lid, capable of holding ~~750 mL (nominal 1 U.S.~~ 750 mL (nominal 1 U.S. qt) of fuel and having a diameter of ~~100 ± 10 mm (4 ± 0.4 in.).~~ 100 mm ± 10 mm (4 in. ± 0.4 in.). There should be no gasket in the lid.

6.1.2 *Closed Circuit Sampler,* holding about ~~4 L (1 gal~~ 4 L (1 gal U.S.) of fuel and being permanently mounted to receive fuel from a fuel line or a storage tank and having inlet and outlet valves to control filling and emptying of the container. The sampler base is normally conical and incorporates the fuel inlet and outlet. The fill port is designed to cause the fuel to swirl around the sides of the clear glass tube. The circuit sampler may also contain hydrometer and chemical water detection ports.

6.2 *Appearance Card and Photographs:*

6.2.1 *Paper Card (Bar Chart),* laminated in clear plastic having five parallel lines of different widths (see ASTM adjunct ADJD417601).

[5] Manual 5, *Aviation Fuel Quality Control Procedures*, 2nd Ed., ASTM International, W. Conshohocken, PA, 1995.

6.2.2 *Appearance Photographs,* a series of standard photographs of the bar chart through a series of samples of different haze levels, numbered from one through six. Photograph No. 1 is the clearest, while No. 6 represents the densest haze (see ASTM adjunct ADJD417602). A fuel sample rated clear and bright will have a rating of "one."

6.2.2.1 The differences between these haze levels are arbitrary and are not intended to represent equivalent increases in suspended water content or particulates. It is essential, therefore, that only the proper approved bar charts and photographs be used.

6.3 *Opaque Sample Containers:*

6.3.1 *White Bucket,* a circular bucket with straight but non-parallel sides and a flat bottom and a minimum capacity of ~~7.5 L (2.0 U.S.~~ 7.5 L (2.0 U.S. gal) and approximately ~~20 cm (8 in.)~~ 20 cm (8 in.) high, either coated with white porcelain enamel or made of stainless steel. Porcelain coatings must be free of dark spots, chips, or other surface damage, most particularly on the bottom of the bucket. Stainless steel buckets shall be made of a rust-resistant steel and have a polished internal surface. The white porcelain bucket should be used for the optimum detection of unusual coloration.

NOTE 1—A quantitative description of acceptable white color is in preparation.

NOTE 2—Buckets made of white, hard plastic have been found to stain a yellow color over time, which can make it difficult to observe a haze or color changes. The use of plastic containers is also discouraged unless provision is made for bonding such containers to the filling line.

6.4 *Color and Particle Assessment Rating Guide:*[6]

6.4.1 This guide contains both a series of photographs of particulates of differing concentrations, each having a different letter rating, and a series of color photographs for rating filter membranes obtained by Test Methods D2276. For this test method, only the particle rating scale is used. The particle rating scale does not bear a direct relationship to the mass of particulates but is simply a way of communicating the amount of visible particulates in the sample.

7. Sampling

7.1 Sampling shall be consistent with the procedures in Practice D4057.

7.2 Draw the sample for a field test directly into the test container using the following procedure:

7.2.1 Ensure that the sampling valve is free of loose solid contaminants. If rust or other loose encrustation is present, remove with a cloth; then flush the sampling valve prior to taking the actual sample.

7.2.2 Ensure the displacement the fuel volume in the piping between the sample tap and the storage tank This displacement volume should be discarded as it may not be representative of the fuel to be tested.

7.2.2.1 All fluid obtained from a filter sump should be kept as the sample.

7.2.3 Rinse a clean test container thoroughly with the fuel being sampled. (**Warning—** ~~Warning—~~Flammable, keep away from heat, sparks, and open flames.)

7.2.4 Draw the sample continuously, opening the valve completely to obtain a full flush. Do not open or close taps or valves during sample draw as this action can affect sample quality.

7.3 If the test is to be conducted on fuel taken in a separate container for laboratory testing, the container should be shaken vigorously before decanting the fuel into the viewing equipment. Sample transfer should be rapid enough to avoid changes in sample temperature.

8. Procedures

8.1 *Procedure A—Clear, Transparent Containers:*

8.1.1 *Open Glass or Plastic Container:*

8.1.1.1 *Visual Observation*—Fill container about three-fourths full. Immediately check for evidence of water or particulate contamination by holding the sample to the light and visually examining for haze or lack of clarity. Close the container and swirl the sample to produce a vortex and examine the bottom of the vortex for particulate matter and water droplets. Also look for brown slime or a water layer on the bottom of the container. Record the particulate and water appearance rating of the sample using the ratings in Tables 1 and 2. Record the appearance of any other contaminant using Table 3 as a guide. Record the ambient temperature.

8.1.1.2 *Use of Bar Chart and Photographs*—Immediately on drawing a sample, place the container into a well-lighted area, avoiding light reflections on the front of the container as much as possible. Place the bar chart directly behind the container, with the lines toward the container and parallel with the bottom of the container. The narrowest line should be at the bottom of the container. Directly facing the container and bar chart, compare the appearance of the bar chart through the sample with the standard photographs. Place the photographs next to the container so that they are lighted similarly to the sample. Select the photograph closest in appearance to the sample. Notice that the differences between photographs consist both of the successive disappearance of lines as well as the gradual lightening of all the lines. Record the number of the thinnest line which is visible through the sample, or record "six" if no lines are visible.

8.1.2 *Closed Circuit Sampler:*

[6] The "Color and Particle Assessment Rating Guide," *SGTP-3940*, is available from Gammon Technical Products, Manasquan, NJ.