



# Standard Test Method for Undissolved Water In Aviation Turbine Fuels<sup>1</sup>

This standard is issued under the fixed designation D 3240; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This test method covers the measurement of undissolved water in aviation turbine fuels in flowing fuel streams without exposing the fuel sample to the atmosphere or to a sample container. The usual range of test readings covers from 1 to 60 ppm of free water. This test method does not detect water dissolved in the fuel, and thus test results for comparable fuel streams can vary with fuel temperature and the degree of water solubility in the fuel.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Terminology

2.1 *Definition of a Term Specific to This Standard:*

2.1.1 *free water*—water not dissolved in the fuel.

## 3. Summary of Test Method

3.1 A measured sample of fuel is passed through an uranine dye-treated filter pad. Undissolved (free) water in the fuel will react with the uranine dye. When the pad is subsequently illuminated by ultra violet (UV) light, the dye previously contacted by free water will fluoresce a bright yellow with the brightness increasing for increasing amounts of free water in the fuel. The UV light-illuminated pad is compared to a known standard using a photocell comparator, and the free water in the fuel sample is read out in parts per million by volume. By varying the fuel sample size, the range of the test method can be increased.

## 4. Significance and Use

4.1 Undissolved (free) water in aviation fuel can encourage the growth of microorganisms and subsequent corrosion in the tanks of aircraft and can also lead to icing of filters in the fuel system. Control of free water is exercised in ground fueling equipment by use of filter-coalescers and water separators.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0 on Aviation Fuels.

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## 5. Apparatus

5.1 *Test Pad Rater*—A device<sup>2</sup> for comparing the fluorescence of the test pad to a known standard, while both are illuminated by the same source of UV light, shall be used. The amount of UV light striking the standard shall be modulated until the total fluorescence of the test pad and the standard are equal; this shall be determined using a photocell bridge circuit null indicator. The light modulating device for controlling the UV light striking the standard shall provide a direct reading in parts per million by volume of free water.

5.2 *Test Pads*—Absorbent filter disks of 25-mm diameter shall be coated on one side with uranine (sodium fluorescein) dye at a concentration of 0.23 to 0.29 mg per 25 mm pad. The test pads<sup>3</sup> shall be individually packaged in hermetically sealed envelopes or other suitable containers. Fresh, unused test pads shall have an orange color over the dyed surface. Any discoloration, unevenness in dye content, or faded (to a yellow color) appearance shall be cause for rejection.

5.3 *Test Pad Holder<sup>4</sup> and Sampling Line*—A test pad holder and sampling line shall be used to draw the fuel sample through the test pad at a rate of 600 to 800 mL/min. Means shall be provided to flush the test pad sampling line and holder immediately prior to use. The test pad holder shall include an orifice of 1-mm (0.040-in.) diameter upstream of the pad to disperse water droplets in the fuel.

5.4 *Tweezers*—Suitable clean, dry tweezers shall be used at all times when handling the test pad.

5.5 *Blotting Paper*—Clean, dry, absorbent paper towels, blotters, etc., shall be provided for blotting the test pad prior to rating to remove excess fuel. The blotter paper shall neither impart color or stain nor leave any residue on the test pads.

5.6 *Sampling Valve Connection*, designed to meet the following requirements: (1) It shall be mounted in the sampling

<sup>2</sup> The Aqua-Glo Series II instrument manufactured by Gammon Technical Products, Inc., P.O. Box 400, Manasquan, NJ 08736-0400 was used in the precision test program. The unit is currently available in a Series III configuration which is changed only in the power supply. All water content measuring components remain of the same configuration as the Series II instrument. Manufacturers who wish to offer similar products are referred to Committee D02 Equipment Replacement Guidelines.

<sup>3</sup> Aqua-Glo test pads used in the Precision Test Program are available from Gammon Technical Products Inc., P.O. Box 400, Manasquan, NJ 08736-0400.

<sup>4</sup> A test pad holder used in the Precision Test Program is available from Gammon Technical Products Inc., P.O. Box 400, Manasquan, NJ 08736-0400.

point and must incorporate a self-sealing quick action coupling designed to mate with a suitable connection leading to the selector valve of the sampling assembly. (2) It must be completely resistant to fuel and be leak proof up to the maximum working pressures to be encountered. (3) It must have a minimum of internal recesses which could cause the holdup of contaminant. (4) It must be provided with a dust cap.

5.7 *Calibrating Standard*, Calibration of the instrument should be performed using a calibrating standard of known values.

## 6. Sampling

6.1 The following procedure is applicable for dynamic line samples only; that is, taking the fuel sample directly from the test system and through the test pad without exposing the sample to the atmosphere or to a sample container. The use of sample containers such as bottles or cans for the temporary storage of the sample will result in large errors and is not recommended.

NOTE 1—The amount of free water in a sample is very sensitive to the temperature of the sample. The use of sample containers such as bottles or cans can result in large errors due to changes in sample temperature, adsorption of water on container walls, etc.

6.2 Attach the test pad holder assembly to the sampling port on the system.

6.3 Flush the test pad holder assembly immediately prior to sampling, displacing the sampling line with at least two volumes of test fuel.

6.4 Remove the sampling assembly, open the pad holder, and insert the new test pad using tweezers making sure that the treated side of the test pad is facing upstream. Installation of a three-way valve immediately upstream of the test pad holder will permit flushing with the test pad in place.

NOTE 2—Do not remove the test pad from the hermetically sealed package until ready for use. Do not allow any discrete water droplets to come into contact with the pad (from rain, sneezing, coughing, etc.). Exposure of the test pad to the atmosphere, especially on humid days, will also ruin the pad in a matter of minutes.

6.5 Pass 500 mL of fuel through the pad, accurately measuring the test sample quantity. Normal sample volume is 500 mL of test fuel, but if the reading is off scale (on high side), sample volumes down to 100 mL in volume may be used. In the latter case, a small graduated cylinder should be used to measure the sample volume.

## 7. Calibration

7.1 The calibrating standard<sup>5</sup> corresponding to a given undissolved water content is placed in the test pad window. Turn on the lamp and press the photocell comparator button. Zero the photocell comparator by adjusting the light modulating lever until there is a steady reading for 10 to 15 s. This may take a minute or longer. Always move the light modulating lever in the same direction when zeroing the photocell comparator in calibration or testing to eliminate errors caused by

play in the lever. If the reading obtained does not agree with the calibration pad rating, adjust the photocell comparator by removing the plug screw on the side of the photocell comparator at the 45° bend. Insert a small screwdriver, and adjust as necessary. Repeat the above procedure until the rating obtained agrees with the calibration pad rating. The instrument should be calibrated prior to use each day, after each hour of use, and when the ultra violet light battery is replaced or recharged.

## 8. Rating Procedure

8.1 Remove the test pad from the sampling holder using tweezers and press between dry paper blotters or absorbent towels to remove excess fuel. To blot, press firmly (about 5 lb force) 3 or 4 times with heel of hand, moving the pad with tweezers each time.

8.1.1 For maximum accuracy the test pad should be read within 3 min after sampling is initiated. If the test pad is not read immediately after sampling, it must be placed in a desiccator to prevent moisture pickup from the air. However, ratings made on dried test pads, that is, not damp with fuel, should be avoided if possible since they will give high and erroneous results. Conversely, rating a pad which has not been well blotted will give a low reading as the excess fuel will absorb part of the UV light and decrease fluorescence.

8.2 Using tweezers, put the pad into the pad rating device. Turn on the lamp and press the photocell button. Continuously zero the photo-cell comparator by adjusting the light modulating lever until there is a steady reading for 10 to 15 s. Always move the light modulating lever in the same direction when zeroing the photocell comparator to eliminate errors caused by backlash. This may take a minute or longer. Turn off the instrument light immediately after use to conserve battery power.

8.2.1 The ultraviolet light must be on to get a reading. This can be checked by moving the light modulating lever from one extreme to another. The photo-cell comparator meter needle should swing violently when this is done.

8.3 Record the instrument reading (estimated to the nearest tenth) and the sample volume. Record the temperature of the fuel.

8.4 Visual observation of the used test pad is often of value. This is easily accomplished by removing the photocell comparator assembly and viewing the test pad. Free water in fuel is normally well dispersed and will form an even distribution of many, small points of yellow fluorescence on the test pad when illuminated by ultra violet light. Large water drops, however, will form a few, large spots of yellow fluorescence on the pad. These large spots may give erroneous readings; the result should be disregarded and a new sample tested.

## 9. Calculation

9.1 The instrument reads directly if the sample volume is 500 mL. Correct the readings for other sample volume by multiplying reading by 500/sample size in millilitres:

$$\text{Free water, ppm} = (\text{meterreading, ppm})(500)/(\text{sample volume, mL}) \quad (1)$$

<sup>5</sup> Replacement calibrating standards are available from Gammon Technical Products Inc., P.O. Box 400, Manasquan, NJ 08736-0400, but only if the fluorescing standard for the instrument is returned for comparison rating.

## 10. Report

10.1 Report the result to the nearest whole number as ppm by volume of undissolved water in fuel, and also the sample volume used in the test. Report the temperature of the sample if available.

## 11. Precision and Bias <sup>6</sup>

11.1 The precision (Note 3, Note 4) of this test method as determined by statistical examination of test results obtained by operator-instrument pairs at a common test site is as given in this section. Each operator used a separate instrument.

11.1.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method exceed the following values only in one case in twenty.

$$\text{Repeatability} = 0.32x \quad (2)$$

where  $x$  = average of two results in parts per million volume over the range from 1 through 60 ppm V (Note 5).

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<sup>6</sup> The results of the cooperative test program from which these values have been derived, are filed at ASTM Headquarters. Request RR:D02-1195.

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11.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working at a common test site on identical test material would, in the long run, exceed the following values only in one case in twenty.

$$\text{Reproducibility} = 0.47x \quad (3)$$

NOTE 3—The reproducibility values above were estimates from results obtained at the same location and on the same day by seven operator/instruments testing identical samples. In the case of this test method it is not possible to obtain meaningful results when fuels are shipped to different locations since water would separate during shipment.

NOTE 4—The presence of fuel additives such as corrosion inhibitors, fuel system icing inhibitors, and antistatic materials may affect the calibration of the test.

NOTE 5—Sample size was not found to be a significant factor in precision. Data were analyzed using a log transformation but the repeatability results are expressed in untransformed units.

11.1.3 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in Test Method D 3240 for measuring the undissolved water in aviation turbine fuels, bias has not been determined.

## 12. Keywords

12.1 calibrating standard; fluorescence; fluorescing standard; free water; sodium fluorescein; undissolved water; uranine