Cold Storage Test

PAFI-RTP-005

PAFI Rig #5 Freezer Test

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PREFACE

This test plan specifies the requirements for conducting comparative materials compatibility screening tests under the FAA's piston aviation fuels initiative (PAFI). This document is derived from extensive FAA and industry experience and best practices for evaluating the suitability of aviation fuels for use in the piston powered general aviation fleet. This document is used by the FAA to compare and evaluate new aviation fuels relative to the performance of 100LL aviation gasoline that meets ASTM D910.

In addition to the candidate unleaded fuel, an ASTM D910 fuel formulation is required for the screening tests under this plan.

This document is not intended to provide a method to obtain data to serve as a showing of compliance to regulatory requirements for the certification of aircraft or aircraft engines.

Furthermore, the material in this document does not change or permit deviations from existing regulatory requirements. This material is neither mandatory nor regulatory in nature. Use of this document or any derivative, in an attempt to obtain an FAA authorization of an alternative aviation fuel, should be pre-coordinated and approved by the appropriate FAA office(s) as part of an approved qualification program.

Successful completion of this test plan provides data that may support both FAA Fleet authorization and development of an ASTM production specification for PAFI Fuels. It also allows the collection of data to be used to generate performance and detonation performance values in support of other candidate

fuel types being investigated under various FAA Research & Development projects.

References made to the Alternative Fuels Program Office or AFPO, refer to the group within the FAA that is responsible for the PAFI program. At the time of this revision, that group is the AIR-650 organization. Please see https://www.faa.gov/about/initiatives/avgas/org_info.

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Materials Test Plan
PAFI-RTP-005
Cold Soak Storage Test

1. SCOPE

This test plan specifies the requirements and procedures for conducting comparative cold storage testing of an unleaded fuel to generate data required for participating in the FAA Piston Aviation Fuels Initiative (PAFI) test program.

This data will be used for the evaluation of an unleaded fuel being tested in the PAFI test program. The data will be used as part of the final evaluation of data for fleet authorization.

Specific objectives of this plan are stated as follows:

1) Execute cold storage exposure testing and collect fuel performance data to assess fuel propensity for separation or other anomalous behavior with changing temperature.

The test plan includes the requirements for confirming baseline condition, test set-up, instrumentation, specimen collection and supporting documentation such as fuel certification documents as prerequisites to the testing identified.

Fuel cold storage temperatures are specified as -10, -20, -30, -40, -50, and -58 °C (14, -4, -22, -40, -58, and -72 °F). Testing consists of chilling the fuel to the test temperature and conditioning for a minimum of 7 ½ hours. A visual inspection of the samples is made at each temperature.

Requirements for confirming test equipment configuration, test instrumentation, and supporting documentation such as fuel certification and equipment calibration/validation are pre-requisites to the testing identified.

1.1. PROVISOS

The following identifies significant assumptions, requirements, and provisions associated with the testing prescribed within this test plan. Note that testing performed pursuant to this test plan provides data supporting FAA fleet authorization for PAFI unleaded fuels. Except in cases where FAA approval of testing is received a priori, where testing is performed on fuel produced to the final formulation, and when testing is witnessed by an FAA designated representative, the resulting data MAY be designated as supporting fleet authorization. Any subsequent change to the fuel formulation outside of specified manufacturing limits will negate the use of any collected data, even if appropriately approved and witnessed by the FAA. Testing performed to this test plan must be witnessed by an identified designated representative of the FAA. This may be achieved using a Designated Engineering Representative (DER) or other representative approved by the AFPO Staff prior to executing testing.

NOTE: In the event testing is conducted outside the FAA's William J. Hughes Technical Center, testing performed to this test plan must be witnessed by an identified designated representative of the FAA. This may be achieved through the use of a Designated Engineering Representative (DER) or other representative approved by the FAA AFPO or PAFI Advisory Committee prior to executing testing.

NOTE: Testing performed pursuant to this test plan provides data supporting 1) FAA fleet authorization for each PAFI unleaded fuel, and 2) the development of an ASTM International aviation gasoline production specification for each fuel.

2. OBJECTIVES

The objective of the Cold Storage Test Plan comparative fuel performance tests is defined as follows.

1) *Determine how the fuel will behave, especially with respect to freezing or separation, as the fuel is cold soaked.*

3. BACKGROUND

Historically aviation gasoline has displayed both a resistance to freezing and an observable stability when the fuel is cold soaked to temperatures as low as -58 °C (-72 °F). This is due primarily to the chemical composition of aviation gasoline produced in compliance with ASTM D910, a result of the military requirements of the 1940s. The requirements were that the fuel have a freezing point no higher than -60 °C (-76 °F).

In order to blend fuels having the necessary detonation resistance, components with different physical properties with respect to temperature could potentially result in a fuel that separates during cold storage, even if it meets the freeze point requirements. This striation could then result in a loss of the octane enhancing component, and concentration of chemicals with human health risks and/or aggressive behaviors towards hardware materials.

Accordingly, the test plan prepared for the FAA PAFI Rig screening test provides for the development of a common set of validation data supporting compliance with both ASTM and FAA certification requirements. Currently there are no published regulations for cold storage properties. ASTM D7826 provides guidance in evaluating the comparative behaviors of fuels and the handling of non-comparative outcomes.

The scope and extent of the FAA PAFI Cold Storage Test plan is defined by TAC-PROJ-016, latest revision which integrates the findings and recommendations of the PAFI Technical Team meeting of October 9, 2014. The cold storage stability test plan documented in PAFI RTP-005 is based upon the cold soak protocol defined in Section 2.4 of FAA contract DTFACT 13-D-00010 Order 0005.

4. PAFI RIG SCREENING TEST PLANS

The matrix of rig screening test plans supporting the test protocols identified in TAC-PRJ-008 latest revision is presented as follows. The test plans will follow a common format with general procedures, processes, and test instrumentation being common to all. The current plan is highlighted in the list below:

RIG SCREENING TEST PLANS

PAFI-RTP-001, Cold Flow Hardware Test
PAFI-RTP-002, Carburetor Icing Test (Incorporated into Engine Test Plan(s))
PAFI-RTP-003, Dynamic/Operational Hardware Test, (Removed)
PAFI-RTP-004, Long Term Storage Test, Ambient and Elevated
PAFI-RTP-005, Cold Storage Stability Test
PAFI-RTP-006, Hot Surface Ignition Temperature Test, (Removed)
PAFI-RTP-007, Full Scale Engine Emissions Test, (Not Released)
PAFI-RTP-008, Comingling Evaluation with 100LL, (Not Released)
PAFI-RTP-009, Dynamic Diaphragm Test
PAFI-RTP-010, Fuel Sump Valve Test
PAFI-RTP-011, Vented Drum Storage Test

Test plans prepared in support of the FAA PAFI test program for unleaded fuels are subject to the following review and approval protocol.

1) PAFI rig test plans follow a format and content consistent with established practice for FAA compliance projects.
2) Draft test plans are furnished to the FAA AFPO office for review and approval prior to release to the TAC.
3) Upon concurrence from AFPO, the test plan will be formally furnished to the PAFI TAC for review and concurrence preceded by FAA Contracts review and authorization for release to the TAC.
4) A final test plan will be released incorporating changes resulting from the TAC review.
5) All changes and referrals to this test plan should reference the latest revision level and date.

5. APPLICABLE FAA, SAE & ASTM REQUIREMENTS

The following is a listing of the applicable FAA, SAE, and ASTM documents which contain information relevant to the testing specified by this test plan.

5.1. FAA REGULATIONS

There are no FAA Regulations applicable to the testing.

5.2. FAA ADVISORY CIRCULARS & ORDERS

There are no FAA Advisory circulars or orders applicable to the testing.

5.3. SAE STANDARDS

There are no SAE standards applicable to the testing.

5.4. ASTM GUIDANCE & PRACTICES

ASTM guidance and standards applicable to the testing identified are listed as follows. Data provided by this test plan will support the development of an ASTM production specification for each of the unleaded fuels.

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

2) ASTM D6304 “Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration”

3) ASTM D7826 “Standard Guide for Evaluation of New Aviation Gasolines and New Aviation Gasoline Additives”

6. DESCRIPTION OF TEST ARTICLES

This test plan utilizes no special test articles beyond the fuels to be tested.

7. DEFINITIONS & TERMINOLOGY

Definitions, terminology and abbreviations specific to this document and to FAA nomenclature are summarized in the following section.

7.1. EXPOSURE

Within this document, the term exposure is the placement of specimens in a test fluid at a given temperature for a given amount of time.

7.2. CALIBRATION

Calibration is a set of actions that establishes that the instrument being calibrated is equal to or reports values equal to a standard. The unknown, the instrument being calibrated, will be checked against a known, the standard, at several different points and adjustments made to the unknown to bring it into alignment with the standard.

7.3. SAMPLE

Within this document the following concept is meant by the term “sample”. A sample is the specific material to be prepared as specimens and exposed to test fluids. For example, 100LL AvGas is a sample, and UL100 test fuel is a second sample.

7.4. SAMPLE SET

A sample set is all of the individual specimens and all of the test fluids comprising a set of samples to generate a set of data. For example, the top, middle, bottom specimens from the 100LL and the top, middle, bottom specimens from the UL100 experimental test fuel at -40 °C comprise the “-40 °C Sample Set”.

7.5. SPECIMEN

Within this document the following concept is meant by the term “specimen”. Specimens are the individual pieces/aliquots collected from the sample materials. For example, the three individual fuel volumes collected from the test sample (the fuel) are the test specimens for a single temperature exposure.

7.6. ULTRA-LOW TEMPERATURE

Within this document ultra-low temperatures are those less than -40 °C (40 °F).

7.7. VALIDATION

As opposed to calibration, validation is the act of documenting that an instrument will actually and consistently give expected results. This may be done by measuring a specimen with a known value and confirming the instrument reports that value within the repeatability of the instrument. If the expected value does not result, validation has failed and some additional action must be taken to repair or adjust (calibrate) the instrument.

8. FUEL CONFORMITY

8.1. TEST FUELS

Each PAFI test fuel shall be shown to conform to the complete specification approved by the AFPO, as documented by a CoA furnished with each fuel batch or bulk volume delivered by the fuel supplier to the test facility. In addition, representative data must be generated by an independent 3rd party laboratory for specific pre- and post-test criteria. Pre-test samples should be from fuel collected from the original shipping containers ‘as received’ by the Test Facility. Analysis must be performed on the fuel samples in accordance with Appendix A. Deviations from the fuel specification shall require approval of AFPO. The full Test Fuel CoA

as well as the pre and post-test analysis specified in Appendix A must be included in the test results report.

NOTE: A five-gallon retained sample of the test fuel 'as received' at the test facility must be collected and stored until completion of the PAFI test program. See PAFI-FHP-001.

NOTE: The impact of differences in a fuel's propensity to draw water (its hydrophilic nature) and the potential for this water to freeze in the carburetor, is considered during Carburetor Icing testing.

A worst-case freezing point fuel is required for the cold storage testing with the fuel blend composition to be identified in advance by the Fuel Offeror with concurrence from FAA AFPO. Worst case freezing fuel is defined as a blend which is compliant with the fuel's specification; either D910 <-58 °C (-72.4 °F) or the maximum freeze point that can occur within the normal production of the test fuel.

9. SAFETY PROCEDURES

This document does not purport to address all safety considerations. This document does not replace or supersede individual instrument documentation, site procedures, or general industry practices. Appropriate safety precautions are the responsibility of the Test Facility conducting the test. The Test Facility shall establish and ensure compliance with the applicable safety and health standards. Prior to initiation of testing, each test set-up shall be inspected for safe practices. Consideration for personal protective gear (PPE) is the responsibility of the Test Facility.

9.1. SAMPLE FILL (REFERENCE ASTM D4057-12, SECTION 5.2)

For safety and protection of the integrity of the samples, during transportation and storage, the use of a sample carrier is recommended. A safe fill of between 70 and 85 vol. % is recommended unless otherwise instructed. Do not fill over 85% of the container volume.

9.2. STATIC CHARGE (REFERENCE ASTM D4057-12)

1) Grounding (D4057-12, Section 5.4.1)
   A number of fires and explosions have occurred as a result of hydrocarbon vapors being ignited by static electricity. If electrical charges are not grounded, they are unable to dissipate and become "static." This static electric charge can accumulate and freely migrate to a single point on the sample container by a difference in electrical potential, then jump off as a high-energy spark discharge to a nearby less charged surface. The spark may be hot and prolonged enough to ignite nearby hydrocarbon vapors present above the lower explosive limit (LEL). This potential shall be

managed by safely dissipating static charges, and through proper grounding, when handling flammable products.

2) Personal Attire (D4057-12, Section 4.5.2)
Footwear or clothing, capable of causing sparks, should not be worn during fuel handling activities in which flammable vapors are likely to be present. Sampling should not be carried out during periods of atmospheric electric disturbance or hailstorms. To ground any static charge on their body, the individual performing the handling should touch a grounded structure prior to handling fuel.

9.3. VAPOR HAZARDS

All testing must be done in compliance with site and local fire safety protocols as well as applicable NFPA regulations. The presence of flammable vapors requires a flammable materials storage freezer. The design concepts are based on the removal of ignition sources from the compressor. The primary intent is to eliminate ignition of the vapors inside the storage compartment by ignition sources also within the storage compartment.

9.4. ICE BURNS/FROSTBITE

This document does not replace or supersede any local or site requirements related to ultra-low temperature exposure. Frostbite or the formation of ice crystals in human tissues occurs at -4 °C (25 °F) or lower. This test requires cold soaking test articles at temperatures from -10 to -58 °C (14 to -72 °F). The testing requires handling these chilled samples at temperature and exposure to a chilled environment (test chamber). Unprotected contact with items chilled to less than -4 °C (25 °F) for periods of time longer than a few minutes can cause frostbite and ice burns.

9.5. PERSONAL PROTECTIVE EQUIPMENT

This document does not replace or supersede any local or site requirements related to personal protective equipment.

9.5.1. STANDARD PPE –

Technicians and test engineers are advised to familiarize themselves with the safety data sheets (SDS) for all the fluids under test. Individuals are recommended to use at a minimum safety glasses or goggles, petroleum resistant gloves, and lab coats or aprons. Closed toed, non-charge isolating footwear is also recommended.

9.5.2. ULTRA-LOW TEMPERATURE PPE –

Respective to cold exposure, technicians and test engineers are advised to consider the necessary personal protective equipment specific to ultra-low

temperature exposure. Examples of recommended PPE include but are not limited to gloves with sufficient conductive protection to permit handling samples of -58 °C (-72 °F) for at least 30 minutes, a laboratory apron with insulative properties, and a face shield. These should be worn over standard laboratory PPE or if necessary, in a place of, recognizing the chemical resistance may be less than that of standard PPE.

10. PRE-TEST REQUIREMENTS

10.1. SPECIMEN IDENTIFICATION

The container used for cold soak exposure shall have a form of permanent sample identification affixed to the container. Due to the exposure temperatures and subsequent condensation during inspection, a non-paper label, such as a metal tag wired to the bottle is recommended. While the bottles may also be marked with permanent markers, be advised subsequent inspections may require the use of a laboratory solvent to remove exterior condensation. This solvent rinse may remove such markings.

10.2. PRE-EXPOSURE BASELINE DATA

When the test commences, a specimen of the test fluid shall be collected. This specimen shall be analyzed for existing water content by ASTM D6304 Karl Fischer, procurement of a baseline infrared spectrum, and baseline GC-MS spectra. These will be used for comparative analysis.

10.3. PRE-EXPOSURE PHOTOGRAPHS

When the test commences, each sample shall have a representative pre-exposure photograph taken. This photograph must include a standard haze chart such as that described in ASTM D4176, Clear and Bright testing, or similar background which shall be placed behind the sample. It is recommended that the set-up for photographs include a repeatable backdrop/surface (white or blue), repeatable lighting, and the ability to repeat camera location. It is recommended that a printed identification label be included in the photo that includes sample identification, and that it is pre-exposure.

10.4. LABORATORY NOTEBOOK

Either a bound notebook or digital notebook shall be maintained for any exposure testing. Technicians shall record each individual specimen's unique identification, any lot or certification information, and all corresponding pre-exposure data. Each test and test method, as well as any equipment identification shall be recorded. The test results report shall document the manufacturer and model of any analytical equipment used. Information related to the instrument calibration or validation shall be recorded.

This notebook shall also be used to record any start times and dates, test conditions such as temperature, visual observations, and the time and date of test terminations.

Anomalies, issues, troubleshooting, unplanned events, and any other observations shall be recorded in the notebook. Final test data shall be recorded and positively connected to the appropriate pre-exposure data.

11. TEST FACILITY & EQUIPMENT

11.1. ULTRA-LOW TEMPERATURE FREEZER OR COLD CHAMBER

The freezer or cold chamber used to conduct this test shall consist of a unit capable of reaching -80 °C (112 °F) and maintaining this temperature ±2 °C (±5 °F). Considerations for the upper range temperature range must be made. If -10 °C (14 °F) is above the maximum upper range temperature of the freezer (which is true for most ultra-low temperature freezers), a standard low-temperature freezer shall also be available (See Section 11.2). Digital programmable temperature control with actual temperature readout is recommended.

11.2. LOW TEMPERATURE FREEZER

If the available ultra-low temperature freezer or cold chamber is not capable of maintaining the higher exposure temperatures, an additional freezer capable of reaching and maintaining temperatures, typically 0 to -40 °C (32 to -40 °F) shall be available. Digital programmable temperature control with actual temperature readout is recommended.

11.3. COLD CHAMBER STORAGE RACKS

Depending on the design of the freezers, racks capable of holding the selected sample containers with sufficient air circulation to facilitate cold soaking are recommended.

11.4. ONE LITER SAMPLE CONTAINERS

While the choice of sample container is at the discretion of the testing facility, the containers must provide optical access for visual inspection, be temperature resistant to -70 °C (-94 °F), and able to resist thermal shock during handling and rinsing for optical access during visual inspection and photography. The lid must also be cryogenic resistant.

One-liter, square HD Borosilicate Media Bottles have been successfully used for this testing.

11.5. KARL FISCHER MOISTURE METER – COULOMETRIC

A Karl Fischer titrator and concomitant chemicals are required to determine the moisture content of the samples. Testing is to be performed per ASTM D6304. Depending on the chemistry of the test fuel, reagents for aldehyde/ketone samples, or an additional oil dryer accessory, see D6304, Procedure C, for amine containing fuels may be required.

11.6. CALIBRATED / VALIDATED LABORATORY MEASURING EQUIPMENT

Testing and measuring require standard laboratory equipment which has been calibrated or validated as appropriate. This list of equipment does not exclude others. Any equipment which has calibration shall have the date of the latest calibration recorded. For instruments using validation measurements, the results of the validation shall be recorded and the means of rectifying any non-compliant equipment documented.

Instrument	Report	Reference
Thermometer/thermocouples	Calibration	N/A

12. TEST WITNESSING

Test witnessing is required for the collection and reporting of data collected in compliance with this test plan. This data is to be used by the FAA as part of their evaluation for fleet authorization. Fuel formulators shall submit a test plan for approval by the FAA before executing testing. Part of the submitted test plan must be a means of test witnessing by an FAA authorized representative.

Testing performed in accordance with an approved test plan shall be witnessed by a representative of FAA AIR600 or their designated representative. The extent of witnessing is at the discretion of the FAA; however, at a minimum the representative shall verify and witness the following segments.

1) Verify certificates of analysis are available for supporting samples as appropriate and for all test fuels
2) Verify instrument calibration/validation as appropriate
3) Inspect test set up (jars, specimen arrays, rigs, ovens, etc.
4) Verify pre-exposure data, record keeping and specimen control
5) Review test plan with test personnel
6) Witness test initiation
7) Witness fuel exchanges at the FAA's discretion and as appropriate
8) Witness test conclusion
9) Witness post exposure testing at the FAA's discretion and as appropriate
10) Verify testing in accordance with test plan

13. TEST PROCEDURE – COLD SOAK TESTING

13.1. MATERIALS

1) ASTM D910 compliant aviation gasoline produced with the highest freeze point within the specification limits.
2) Candidate fuel(s)

13.2. SPECIMEN PREPARATION

13.2.1. TRANSFER FUEL

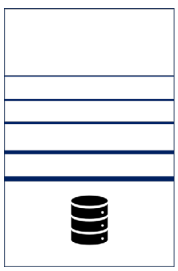
Transfer fuel samples into labelled glass bottles. Fill the bottles to ~85% volume fill.

13.2.2. AMBIENT WATER CONTENT

At the time of testing, collect a specimen of the fuel "as is". Measure the ambient water content of the test fuels by Karl Fischer Coulometric per ASTM D6304 and record the values. Because of the temperature dependence of water content, this specimen shall not be allowed to warm or cool prior to the analysis. Immediate testing is recommended.

13.2.3. PHOTOGRAPHY

Photograph samples by placing a visual indicator such as an ASTM D4176 Haze Chart or similar behind the sample bottle. Provide repeatable lighting with minimum light glare. Photograph each sample. It is recommended that positive sample identification be included in the phtograph.



13.2.4. PREPARE COLD CHAMBER

Place the samples into the freezer rack and bring the freezer to the initial test temperature of -10 °C (14 °F).

13.3. EXPOSURE

1) Carefully place sample bottles into sample racks. Free air movement around the sample bottles will provide for even cooling. **CAUTION:** Placing room temperature sample bottles into the freezer already at an ultra-low temperature risks sample bottle breakage due to thermal shock.

2) Allow the samples to chill for a minimum of 7 ½ hours before collecting specimens. Record actual conditioning time. This exposure time includes the time reaching the target temperature.

3) Either manually or electronically confirm the actual freezer temperature over the conditioning period. Variations greater than 2 °C are allowed during the cooling period, but the test temperature should stabilize within an hour after reaching the target temperature.

4) After at least three (3) hours exposure time at the target temperature, not including the time to reach the temperature, carefully remove a sample bottle. **Do not tip or agitate the sample during the removal. Caution:** *Frostbite/freezer burn risk during sample container handling*. **NOTE**: Minimize the time the cold chamber is open to minimize temperature swings in the chamber.

5) Due to ambient humidity, a layer of condensation ice is likely to form on the bottle surface. This is best remediated for visual inspection and photography by rinsing the bottle external surface with cold/cool isopropanol, ethanol, methanol, or other laboratory solvent capable of removing the water and not itself freezing on the bottle surface. Collect rinsate per local health and safety requirements.

   Visually inspect the sample for water, ice, or waxy formation within the sample, physical separations in the fluid, or other visual abnormalities. Record the observations and specifically photograph any observations.

6) Immediately photograph the sample using the same haze chart, lighting, and other conditions as original photography. Special attention should be paid to capture any visual anomalies. **Caution:** There is a breakage risk due to thermal shock. Minimize the time the containers are outside of the chamber.

7) Return the sample bottles to the freezer rack and lower the freezer temperature to the next lower value. Exposures are to be performed at -10, -20, -30, -40, -50, and -58 °C (14, -4, -22, -40, -58, and -72°F).

8) Repeat steps 1 through 7 for each exposure temperature.

13.4. POST EXPOSURE MEASUREMENTS

No post exposure measurements, except the photographs required.

14. PASS/FAIL CRITERIA

In general, it is not expected that a fuel will display measurable stratification or separation of the fuel blend components. Fuels with higher hydroscopic tendencies may display more noticeable water separation with the temperature reductions. While not grounds for failure of the fuel in and of itself, the propensity to form large ice aggregation layers is undesirable, especially when occurring at higher temperatures.

Actual separation of fuel components should be considered grounds for failure.

15. TEST PERSONNEL

The testing source shall identify a single POC for conduct of this testing. This POC shall be equivalent to a Test Director who shall have the authority for oversight and supervision of those conducting the test. The identified POC shall have responsibility during the test for decisions regarding executing and integrity of the test. This local POC for the testing shall have the FAA point of contact clearly identified and contact information available.

The local designated POC is not a FAA designated representative, and does not have authority to witness testing for the FAA. While the FAA may choose to identify this person as a designated representative, this identification as such is solely at the discretion of the FAA. Any identification of the POC as the designated FAA representative for the purposes of witnessing tests must be made prior to any testing occurring.

16. TEST RESULTS REPORT

The objective of the testing specified is to generate data supporting a fuel formulator's participation in the FAA PAFI testing program with the intent of demonstrating the fuel formulations remain within acceptable limits for the use of the offered fuels. The report documenting the test results pursuant to this Test Plan shall include the supporting data, observations, test articles, and fuel certifications. It shall also include the identification of test equipment used, and

evidence of equipment calibration or validation as appropriate. A table showing graphically the test results, compliance to the pass/fail criteria, and the actual test results shall be provided.

17. REFERENCES

In addition to the reference material of Section 5, the following references are related to the testing described.

1) ASTM D910, "Standard Specification for Aviation Gasoline."

2) PAFI TAC-PROJ-016

3) FAA UAT ARC Final Report, dated 17 February, 2012.
http://www.faa.gov/about/initiatives/avgas/archive/2012-10-05

– END OF TEXT –

APPENDIX A
TEST FUEL COA REQUIREMENTS

Note that this information is required for the candidate fuel, as well as for any MS100LL and FBO100LL fuels that are used during the testing.

PRE AND POST TEST FUEL ANALYSIS PARAMETERS

PROPERTY	TEST METHOD
Distillation	D86
Viscosity	D445
Surface Tension	D1331
Water reaction	D1094
Density	D4052
Moisture Content by Karl Fischer	D6304

– END OF APPENDICES –